APR 1917

# COMPRESSED AIR MAGAZINE

DEVOTED TO THE USEFUL APPLICATIONS OF COMPRESSED AIR

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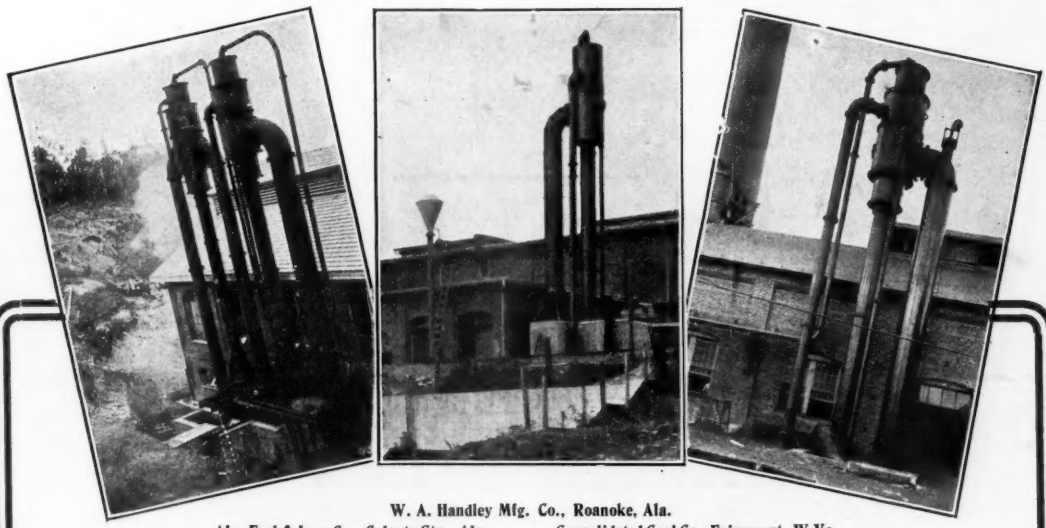

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# COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC

Vol. xxii. APRIL. 1917 No. 4.


## COMPRESSED AIR IN A MODERN TANNERY

BY CHARLES C. PHELPS

One of the largest tanneries in its locality is the plant of the J. H. Ladew Co., located at Lincoln Highway and Passaic River, Newark, N. J. It specializes in the tanning of sole leather and belting butts, the capacity being 400 hides a day.

Water from the city mains is used in the various departments of the plant excepting the beam house in which the initial manufacturing process takes place. It has been found by experience that water taken from a well on the premises is much better adapted for beam house purposes than the city water, as it brings about a condition of the hide substances which puts them into better condition for the subsequent tanning processes. Judged by other standards, however, this water is of poor quality, which is probably due to the proximity of the well to the highly polluted Passaic River.

Formerly, the water was raised from this well by means of an "air lift" system for which the compressed air was supplied by a steam driven compressor. Recently, the plant has been converted extensively to electric drive and it was decided to install an electrically operated compressor to supply the air for pumping. At the same time the well piping was redesigned and the new plant was put in operation Aug. 14 of last year.

The natural flow of the well is somewhat limited, the pumping capacity being restricted to about 50 gal. a minute. There is, however, another well located about 1000 ft. distant, hence it will be a simple matter to operate the second well from the same compressor should the necessity for more water arise.

Compressed air is also used for other purposes besides pumping and it is expected that these uses will be extended in time, hence a compressor large enough to have considerable reserve capacity was purchased.

The well is lined with iron casing pipe 10 in. in diameter down to 80 ft. from the surface, this part penetrating soft ground. From the 80-ft. level down 320 ft. farther, the well has been drilled 8 in. in diameter through solid rock and left uncased. The discharge pipe extends into the well a distance of 317 ft. from the ground level. It is 3¼ in., inside diameter, for a distance of 160 ft. from the bottom. Here it is joined by swedged nipple to piping, 2¾ in. inside diameter, which extends 157 ft. to the surface. The latter piping extends a further distance of 20 ft. above the ground level, at which height the water is discharged into a tank. The latter is 16 ft. in height by 16 ft. in diameter.

As the column of aerated water ascends, the bubbles of air expand due to diminishing pressure. It is, therefore, in the upper part of the discharge pipe that slippage losses are greatest, not only due to the expansion of the air but also due to the coalescence of the bubbles. By reducing the size of the pipe toward the upper end, the discharge velocity is increased, preventing too rapid expansion and coalescence of the air bubbles and further reducing slippage losses by a quicker discharge, the slippage being more or less proportional to the time of discharge. The gain due to this cause more than offsets the greater pipe friction loss in the smaller pipe, increasing the overall efficiency.

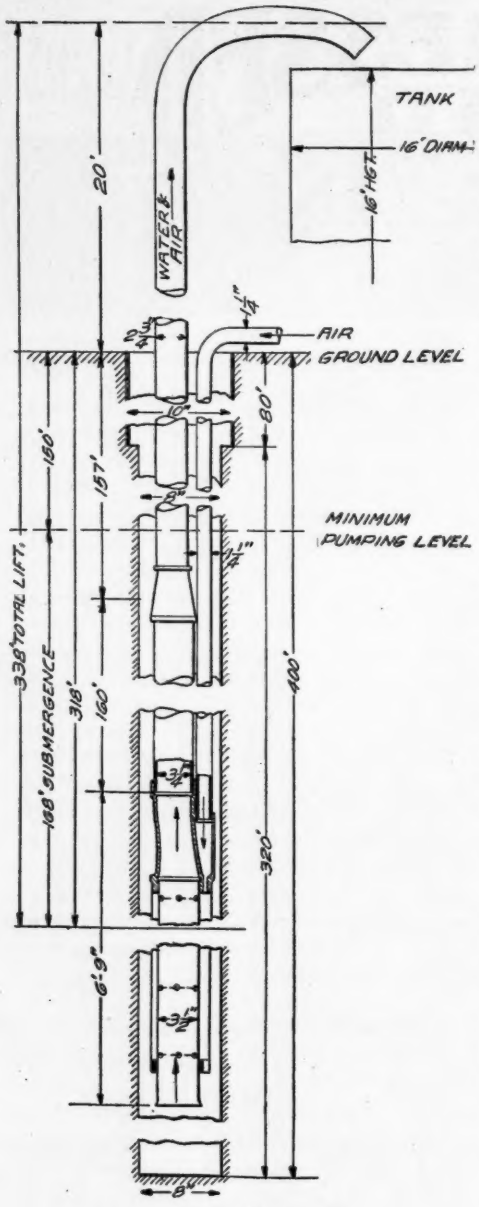



FIG. 1.

Connected to the bottom of the discharge pipe is a foot piece which is known as a Size 5 "Imperial" Class "VA" air lift pump. This increases the discharge length slightly, so that the approximate length of the discharge pipe from the point of air entrance to the tank inlet is 338 ft. The air pipe, which is 1¼ in. inside diameter, is run down the well outside of the water discharge pipe, connecting with the foot piece. These various connections are shown in Fig. 1,

Figure 1 also shows the details of the foot piece. It consists of an outer shell or casing with an inside tube of brass, the latter having a series of rings of small holes drilled as indicated. These rings of holes are spaced in such a way as to create sufficient back pressure in the foot piece to prevent slippage losses and to regulate the admission of air to the rising column of water. The water rises between the casing and inner tube covering a certain number of the perforations, and permitting the air to pass through the perforations above. The air pressure is initially regulated by the throttle so that air will pass through a sufficient number of perforations to give maximum efficiency. Furthermore, the fine openings divide the air into very fine streams giving a highly effervescent effect to the water, which is the most efficient manner of operating an air lift. Scale, dirt, etc., that might enter the foot piece from the piping, cannot clog the perforations as foreign substances are free to pass through the unobstructed openings between the outside casing and the inner tube.

The normal water level when not pumping is practically the same as that of the adjacent Passaic River, that is a few feet below the ground level, but, when pumping the water level falls rapidly until it is maintained at about 125 to 150 ft. below the surface. At the lower pumping level, the running submergence is 318 ft.—150 ft. = 168 ft., and the ratio of submergence to total lift (percentage of submergence) is 168÷338×100=50 per cent. approximately. An air pressure of about 125 lb. per sq. in. is required to start pumping, this air pressure exceeding the pressure of the head of water in the well. After the water is flowing freely, the normal air pressure carried at the head of the well is 70 lb. per sq. in.

The compressor plant is shown in operation in Fig. 2. It is an Ingersoll-Rogler, double-acting, single-stage machine of 8-in. stroke and 9-in. cylinder bore, operating at 250 r. p. m. The compressor is connected by short belt drive with a 25-hp. (nominal) alternating current General Electric motor. Figure 3

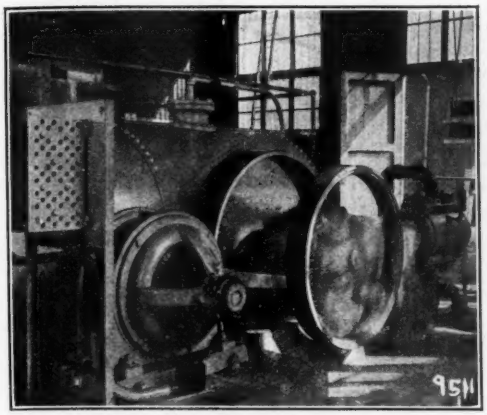



FIG. 2.

shows an end view of the compressor plant; the small pipe passing to the floor on the extreme left leads to the well.

The compressor discharges into an upright receiver 6 ft. in height by 36 in. in diameter, shown in Fig. 4. An unloader keeps the pressure in this receiver between 85 and 95 lb. pressure. When the pressure reaches the higher figure, the motor is stopped and when the pressure in the receiver falls to the lower figure the motor starts up automatically. Of course, the unloader is not allowed to act while the well is starting up at 125 lb. air pressure. The air receiver pressure is indicated on the gage adjoining the receiver on the left (Fig. 4). The pipe extending to the left conducts the air to the well. Between the two gages on the left, the air pressure is throttled down to about 70 lb. as indicated on the left gage.

The connection below the safety valve (Fig. 4) leads to a second receiver from which air is taken for agitating purposes. This receiver, shown on the right of Fig. 3, is of horizontal type, 12 ft. long by 54 in. diameter. The problem here was to furnish a large reservoir kept full of air so that pressure might be available for agitation at any time, even though the well might be out of operation at the moment. A single large tank would require too long a period to build up sufficiently high pressure to start the air lift and, with such an arrangement, a sudden heavy demand for air for agitation might reduce the pressure so much as to render the air lift inoperative. Hence it was decided to apply a double receiver arrangement. The small receiver supplies whatever pressure is necessary for pumping and it responds quickly to the demands made upon it. The surplus air escapes to the larger receiver, gradually building up pressure in the latter.

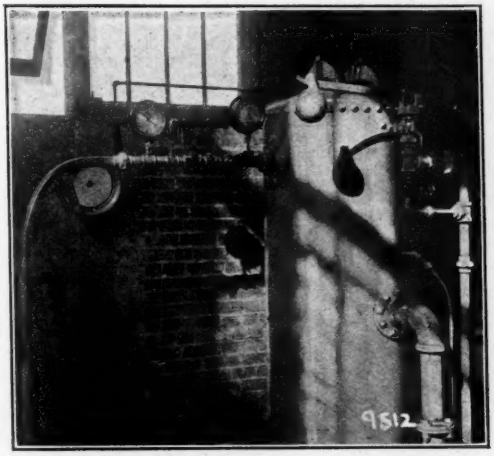



FIG. 4.

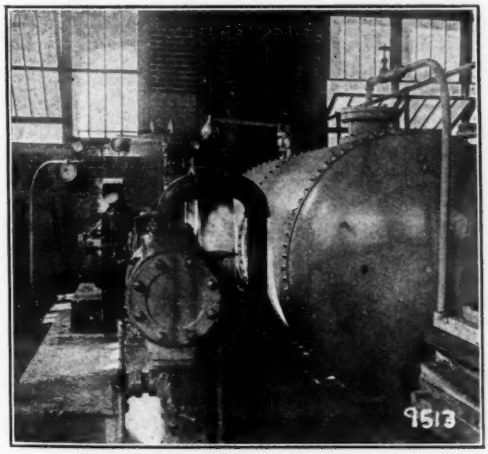



FIG. 3.

Piping connections between the two receivers are shown above to the right in Fig. 4 and more clearly in Fig. 5. A blank diaphragm with a 3-16 in. diameter aperture drilled in it is inserted between the two flanges shown here. This insures that air will not be drawn from the small tank at so rapid a rate as to interfere with the pump air supply. The air pressure in the larger receiver

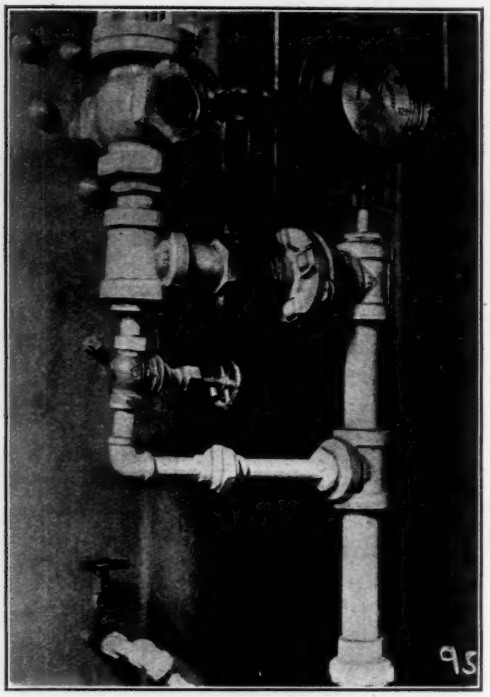



FIG. 5.

is indicated on the gage shown to the right in Fig. 4. The large valve beside the aperture may be closed when starting the air lift and whenever it is desired to cut out the large receiver. The small bypass valve permits filling the large receiver more rapidly, if desired. The plan of utilizing an aperture instead of a check valve was considered preferable because with this arrangement the large receiver acts as an equalizer after the normal working pressure is reached, lessening the service required to the starting and stopping mechanism. As the pressure tends to build up in the small tank, the large tank takes the surplus air and as it falls the aperture permits the air to return from the large tank, thus keeping the pressure range constant throughout the entire system between the limits of 85 and 95 lb. The brake horse power required at the motor to maintain this pressure is about 23 hp. The piston displacement of the compressor is 145 cu. ft. of free air per minute, which includes air used for both pumping and agitation,

Fig. 6 is a view in the beam house which contains a great number of vats embedded in the concrete floor. These vats contain the solutions in which the hides are first immersed preliminary to the removal of adhering flesh and hair. It is in connection with this department that the air lift water is employer. The procedure is to connect in a long strip perhaps 40 or 50 hides and then reel them upon the drum shown in the background of Fig. 6. The drum truck is then wheeled over one of the vats and the string of hides is unreeled into the vat. Before immersing the hides it is necessary to agitate thoroughly the solutions. For this purpose compressed air has been found to be excellently adapted. Several tubes, about 8 ft. long and ½ in. in diameter, connected with the compressed air supply by rubber hose, are used for agitating Each is capped on the end and has several perforations through which the air escapes. The tube is inserted to the bottom of the vat, the air is turned on, and in a few seconds the contents of the vat have been completely mixed. Fig. 6 shows how violently the solution is stirred, forming heavy froth on the surface. The vats in the background had not been subjected to agitation, but the one in the right foreground had been subjected to the air mixing only a few minutes before.—*Practical Engineer.*

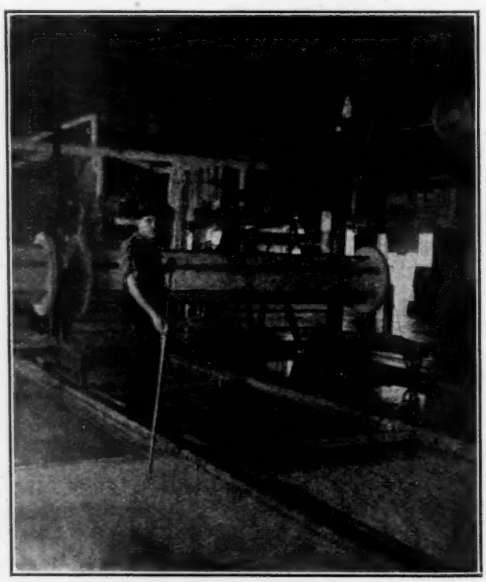


FIG. 6.

## SUBAQUEOUS TUNNELING AT ITS WORST

BY CLIFFORD M. HOLLAND*

One of the four pairs of tubes now being built under the East River, New York City, in connection with the contracts for the so-called "dual" system of rapid transit subways, passes under the East River at Old Slip, Manhattan. At this point considerable difficulty was experienced in holding the compressed air in the tunnel headings, due to conditions at the face of the excavation where the shield was partly in rock and partly in earth. This earth comprised very largely filled ground containing piling and old cribbing. At the water front, furthermore, the profile of the tunnels intersected the base of the South street bulkhead wall, requiring the removal of its concrete foundation throughout the entire thickness of the wall.

The method of excavation was to drive a bottom heading of about 150 feet, into which a concrete cradle with steel rails imbedded was placed for the shield to slide on. The shield was shoved ahead on the imbedded rails 2 feet 2 inches at a time by the action of the shield jacks. Seventeen jacks were distributed around the periphery of the shield and their combined thrust, under a hydraulic pressure of 5,000 pounds per square inch, amounts to about 2,500 tons.

After each shove by the jacks one of the cast-iron rings with which the tunnel is lined was erected behind the shield inside the overlapping tail. Each ring is 2 feet 2 inches long and each consists of nine plates and a key, and is put into place by means of a hydraulic erector attached to the rear of the shield. The erector picks up each plate and pushes it into place, holding it there until it has been bolted to the last completed ring. The soft ground at the top was supported by breasting boards in order to prevent a run of material at the face of the excavation while the rock was being drilled and blasted with light charges. Progress under these conditions averaged about five feet every twenty-four hours.

In tunneling through soft ground under the river compressed air is used to drive the water out of the surrounding material and to prevent water from flowing into the tunnel, thus permitting the excavation to be done under dry conditions. The diameter of the heading on the present work is about eighteen feet, and as it is necessary to have the air pressure high enough to balance the water pressure at some point below the top of the shield there results an unbalanced pressure at the top of the tunnel due to the excess of air pressure over the water pressure at this point.

Blowouts in tunnel headings are caused by this unbalanced pressure, and in order to maintain a state of equilibrum it is necessary to have a considerable amount of material over the top of the shield as a dead weight to counterbalance this excess air pressure. Where the tunnels are under the river a thick blanket of clay is deposited in advance of the shield to serve as a cover through which the compressed air escaping from the face of the excavation cannot pass.

As long as the escape of the compressed air from the tunnel heading can be spread out around the edges of this covering blanket the danger of a blowout is largely eliminated, but if the escape of compressed air be all at one point, it is only a matter of time before it works a channel through the ground overhead and a blowout is almost certain to result.

It has been customary on this work to take daily soundings in advance of the tunnel shield in order to learn how serious the scouring of the river bed due to the escape of compressed air has been during the twenty-four hours previous, and if it appear that the thickness of the river bed has been materially diminished, additional blanket is deposited from scows in order to restore the cover to the proper depth. The thickness of the clay blanket required can be computed theoretically, but the uncertainty of the condition of the bottom of the river bed is such that no great reliance can be placed upon the computations, as a single hole not located by the sounding party is liable to result in a blowout. For this reason considerably more clay blanket is placed in advance of the tunnels than is theoretically required.

In determining the safety of conditions at the face of the excavation, the amount of cover over the top of the shield is only one of several factors which have to be reckoned with, as the escaping of the compressed air at the cutting edge and tail of the shield also de-

*New York Public Service Commission.

pends largely upon the character of the material through which the tunnel is being driven. Oftentimes a "blow" on the river surface which is violent is not a serious matter owing to the porosity of the ground permitting a free escape of the compressed air even though there is sufficient material to withstand the unbalanced air pressure, while a small, insignificant blow in compact material may give a false sense of security. The best method of meeting this situation has been to profit by experience and never permit the cover overhead to become less than a fixed minimum.

Several delays varying from a few days to a month were caused by blowouts in the early stages of this work, two occurring while the tunnels were still under the city streets, and two where the tunnels were passing under the river bulkhead wall. Of these blowouts the most serious one occurred in the evening of December 1, 1915, preparatory to making a shove for a ring. The rock at the center of the shield directly under the breasting was shot with the men back at the tunnel bulkhead where they had retreated as was customary. Immediately after the blast the pressure in the chamber dropped from 15½ pounds to 11 pounds, and the men went into the emergency lock in the top of the tunnel preparatory to going out, as such a drop in pressure indicated that a blowout had occurred at the face of the excavation. After a few minutes, however, the tunnel, which had fogged up due to the drop in pressure, cleared as the air pressure increased again to 15 pounds, and since this indicated that the inrush of material at the face of the excavation had probably choked the blow, the men returned into the heading.

Upon investigation it was found that there was a bad blow of compressed air at the cutting edge of the shield and every effort was made to stop the blow by feeding into it bags of sawdust, empty bags, hay, or anything else that could be thrown into the opening. After about five minutes a second blow occurred and the pressure again dropped to 11 pounds. The tunnel immediately fogged up as had occurred previously, and the center of the heading blew out. This produced such a strong rush of compressed air that several of the men were nearly drawn into the hole, for at the time there were six men in front of the shield attempting to stop the leakage of compressed air. One of these men was drawn into the opening up to his shoulders and was with difficulty pulled out by the other men who clung to the shield and rock. If it had not been for the rock in advance of the shield probably the whole six men would have been lost, but this gave them a firm support in addition to the shield against which they could brace themselves and resist the outgoing compressed air. All this took place in a very few seconds and the men barely escaped before the heading filled up.

The men left the tunnel by means of the emergency lock as the water kept gaining and it was evident that nothing could be done to regain the heading from within the tunnel. The heading was regained some time later by dumping additional cover in advance of the shield from scows loaded with clay, which filled the hole in the bottom of the river so that the tunnel would hold compressed air. After waiting several weeks the air pressure was raised and after mucking out the heading the work proceeded as before the blowout.

A similar blowout under the slip at the foot of Montague Street, on the Brooklyn side, where there was a full soft ground face, resulted in three men being blown out of the shield up through the bottom of the river, only one of whom came through alive.

To meet such an emergency as a blowout, there are two provisions made for the safety of the workmen. A safety screen, extending about one-third the distance down from the top of the roof, is always kept in position to serve as a trap for the escaping compressed air. A seal is made as soon as the water reaches the bottom of the screen so all the compressed air cannot leave the tunnel. In addition there is an overhead runway suspended from the roof of the tunnel, extending from the shield under the safety screen back to the emergency lock located in the upper part of the concrete bulkhead. This lock is always kept open into the heading ready for any emergency.

In one of these blowouts a rather novel expedient was resorted to in order to reach the valve on the blow-pipe located near the shield. As the tunnels are on a down grade this valve was at the lowest point in the tunnel and, if it could be reached, by opening the

valve it would be possible to blow all the water out of the tunnel heading without having to wait until additional pumps or new blow lines were installed.

One of the "sand hogs" who had had experience in diving volunteered to put on a diver's suit and go down into the heading under compressed air and open the valve. He made a successful trip down into the tunnel shield but reported that the river mud which had come in at the time of the blowout had entirely covered up the valve so that he could not reach it.

After each one of these blowouts the material in the tunnel heading was found to be a most curious mixture composed of river mud, paving blocks, brickbats, broken bottles, etc., and in one instance a live fish was found swimming around in the water.

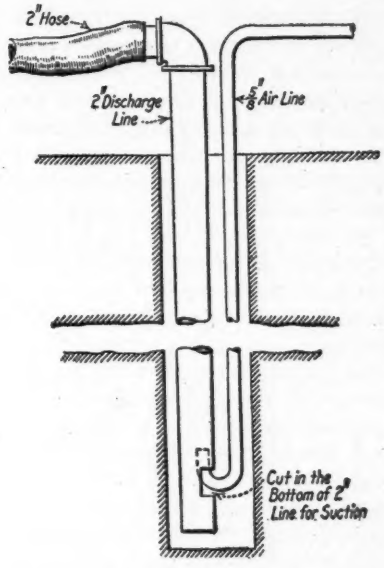
The headings of the north tube of the Old Slip-Clark Street tunnel under the East River were "holed through" on November 28, providing an early Thanksgiving celebration for the "sand hogs" and other workers, the contractors and the commission's engineers.

There have averaged 500 men working in the four headings of the Old Slip-Clark Street tunnel. At one time the digging was being carried on under 37 pounds air pressure, which was the maximum reached. The maximum allowed is only 50 pounds to the square inch. When the pressure was at its highest an average of more than a thousand men were employed daily, owing to the short shifts permitted by law for caisson workers. At this period of the work the men were employed only one and one-half hours at a stretch, entering the tunnels twice daily for an aggregate of three hours. The air pressure at the time of "holing through" had been reduced to 18 pounds and will be continuously reduced as the tunnel is caulked and made water tight, so that normal pressure will have been reached by the time the tunnel is ready for its concrete lining.

Maximum progress made on the tube just opened was 33 feet per day and the monthly maximum 343 feet. Average progress per day was 4.9 feet.

Shafts are located at Old Slip and Front Street, Manhattan, and on Furman Street at the foot of Clark Street, Brooklyn. The section has a total length of 5,900 feet, while the distance between the shafts is 3,800 feet. There is considerable shield driven tunnel work on the Brooklyn side. The contract price was $6,469,916.25.

The tunnel is 17 feet 6 inches in diameter and consists of two single track tubes. At greatest depth the bottom of the tunnel is 88 feet below the surface of the river.




## AN UNDERGROUND AIR LIFT

BY THOMAS HOGARTH

The following is a description of a simple contrivance that I devised for the purpose of doing away with an underground pump. Similar devices have doubtless been used by many mining men, but at the same time there may be others who have never seen them, or perhaps have never heard of them.

The water in a mine of which I took charge was bad. The pumps and the pipes all had to be wood lined, otherwise they would only last a week or two before they were eaten out. In one place in particular the water was extremely troublesome, since it would eat the water end of the pump away in two weeks. The amount of water encountered at this point was not large, being just about sufficient to keep a 2-in. pipe flowing full. I suppose the management did not think it worth while to put in a wood-lined pump and pipes for this small quantity of water, yet it was a constant source of expense, owing to the necessity of changing the pipe and getting new pumps.

It occurred to me one day that an air lift

might be employed for handling this water. I brought this device to the attention of the general superintendent, and he assured me that if the trial lift be made to work he would gladly purchase brass pipe of which to make a permanent one.

The low place in the heading where the water collected had been partly filled with dirt. I secured a 20-in. terra-cotta pipe and put it over the spot where I wanted the hole dug for the air lift. The dirt was then removed from the inside of this pipe, and in this way it was lowered into the debris. Before reaching solid rock, however, some old timber was encountered. It was necessary, therefore, to remove the terra-cotta pipe and cut away this timber, after which the pipe was lowered as before until solid rock was struck.

A 4-in. drill was then made from an old puncher pick on the end of which a 1¼-in. pipe was welded. This made a fairly good drill for the purpose. With this drill and a piece of 2-in. pipe with a bolt in the bottom used as a sludge pump, a 4-in. hole 12 ft. deep was easily put down by two men.

When this drillhole was completed I took a 2-in. pipe and about 8 in. from the bottom I cut a hole 6 in. long and half the diameter of the pipe in depth. On the upper end of the pipe I placed an elbow into which a nipple was screwed, this in turn connecting with a piece of hose. A length of 5-8 in. pipe was also secured and the end formed into a sharp return bend, this end hooking into the opening in the lower end of the 2-in. pipe. The whole was then lowered into the hole, after which the upper end of the 5-8 in. pipe was connected to an air line that had been employed for driving the pump that was formerly in use at this point.

When all was completed the air was turned on. The effect was surprising. Water was thrown all over the place. The air was consequently throttled down to about half a turn of the 5-8 in. globe valve. The device then practically threw a steady stream of water, completely filling the 2-in. pipe.

I never got the brass pipe that had been promised, but when the iron pipe eats away it does not take more than about 2 hr. to put in a new one. Of course, this is much more satisfactory and cheaper than buying and placing new water ends on the pump or furnishing new section and discharge lines.

Where compressed air is available, the method that has just been described is extremely handy for removing water from low places. I do not know, however, how it would work if the discharge line was a long one.—*Coal Age.*

[It is to be supposed that the 5-8 in. pipe above spoken of was standard ½ in. pipe, the inside diameter of which is almost exactly 5-8 in.—Ed. C. A. M.]

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## AIR SUPERSEDES STEAM FOR OIL BURNERS

BY C. W. HUNT, JR.

A compressed air plant with an interesting story of its own was installed about a year ago at the works of the California Brick Company, at Niles, California.

This brick company had formerly used steam for the oil burners at their kilns, but had found that the variation in pressure due to the use of steam made it necessary to use considerably more boiler power than they thought they should use, and therefore they decided to try out compressed air for the service.

They bought a 14x10 Class ER 1 compressor driven by an electric motor, the machine having been put into operation about 15 months ago, and in the first seven months of service was never shut down, day or night. It supplied air at about 35 lb. to the receiver, which meant about 30 lb. at the oil burners in the kilns.

The arrangement for this oil burning installation is a continuous line of kilns with an air pipe and an oil pipe alongside, and when a kiln is started up it is kept at full blast for four days and then allowed to cool down for three days. They have here 24 kilns used exclusively for burning pavement brick, and the service which the compressor renders has cut down the cost of burning the brick to about 25% of what it was before with the use of the boilers, as the actual power consumed is now only about 42 B. H. P. where previously they had two 100 H. P. boilers in full continuous service, with one to spare for shut-downs; and these boilers have never been fired since the compressor was installed.

San Francisco, Cal.

## INTERCOOLER EFFICIENCIES

BY FRANK RICHARDS

Two stage air compression for the working pressures most commonly used, say 6 to 8 atmospheres, absolute, may be said to be now practically universal, at least where new compressors are installed, and even for pressures as low as 4 atmospheres two stage compression is well warranted and quite frequently employed. The practice has not only strong theoretical backing but also the endorsement of practical experience.

Various advantages may be cited for the arrangement: an actual reduction of power output per unit of air delivered, a more equitable distribution of load per revolution or cycle of operation, prevention of high temperatures for the working surfaces and consequently better lubrication, the elimination of moisture and the delivery of the air in better condition, both for transmission and for ultimate use.

The employment of two stage compression is entirely for the sake of the cooling of the air and the consequent reduction of volume which may be effected between the stages, and therefore the entire responsibility for the economy and practical success of two stage compression rests with the intercooler. Since the general adoption of two stage compression, under the stimulus of competitive manufacture and the constant aim to attain to approximately perfect efficiency, the intercoolers have been successively improved until at present there is little more to look for in that direction.

With perfect intercooling the temperature of the air entering the high pressure cylinder should be no higher than the intake temperature of the low pressure cylinder, but this is not attainable. Efficient intercooling is considered to be attained when the air is cooled to within 20 degrees F. of the entering cold water temperature. Compressor builders can show actual intercooler temperature reduction to within 17½ degrees of that of the cooling water with a flow of 2½ gallons per minute per 100 cu. ft. of free air, and to 14½ degrees with 4 gallons of water per minute.

The intake air temperature and the temperature of available cooling water, with the resulting compression efficiency or economy, must vary greatly with the seasons. In the winter months when temperature is low and the air is dense a compressor will deliver more air with less power input than in the hot summer months. The following are quite within the possibilities of working air temperatures in the ordinary range of the seasons:

| Air Intake Temperature | Temperature of Air Entering Intercooler |
|---|---|
| 70 deg. F. | 254 deg. F. |
| 32 deg. F. | 175 deg. F. |
| 0 deg. F. | 145 deg. F. |

The intercooler air pressure of course will not vary, as this is determined by the relative capacities of the low pressure and the high pressure cylinders, regardless of the terminal pressures.

Now it is readily seen that an intercooler could not possibly satisfy the theoretical requirement of delivering the air to the high pressure cylinder at the same temperature at which it enters the low pressure cylinder if the free air temperature was 20 deg. and the cooling water temperature 50 deg. Operating under such conditions would impose an overload with power input exceeding normal by about 12%. With air intake at 70 deg. and cooling water at 50 deg. it would be easily possible for a good intercooler to deliver the air to the high pressure cylinder also at 70 degrees, this constituting what might be called perfect intercooling efficiency according to the definition.

### WATER JACKETING

Proper water jacketing of cylinder and heads is an important detail of compressor design, and here also there are possibilities for great differences in efficiency. Hot air is in direct and constant contact with the cylinder heads and very effective cooling may be accomplished here. It has been found that about 11% of air cooling is effected by cylinder jackets, and that the difference between a deep head jacket with proper circulation and one so shallow and so piped as to be non-effective can show a loss in air capacity of 2% and increase in horse power of 3%. Some designers have held the idea, which of course it is impossible to substantiate, that the heated film of air next to the head in the clear-

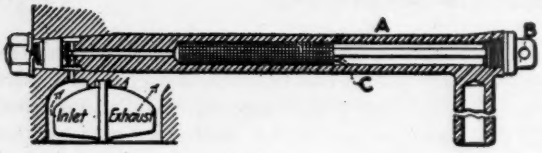



FIG. 1.

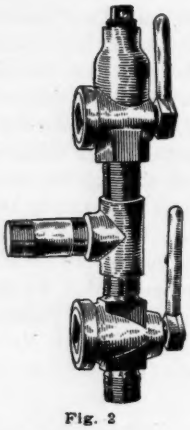


Fig. 2

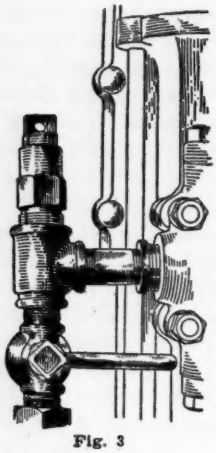


Fig. 3

Fig. 4

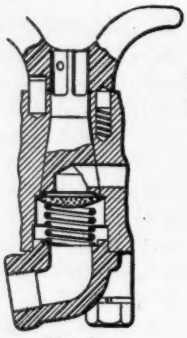


Fig. 5

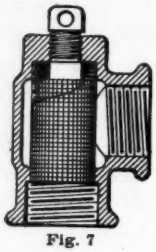
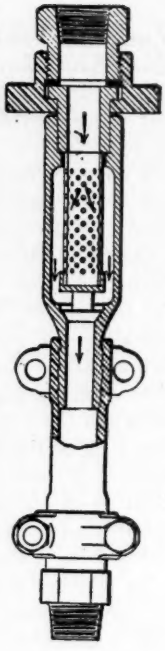


Fig. 7



ROCK DRILL LUBRICATING APPLIANCES.

ber. Before starting the machine, oil plug B is removed and the chamber in the handle filled with liquid grease. As the machine runs, the pulsations of the air in the supply chamber of the chest draw the oil through the porous plug into the machine. Means are provided to exhaust any pressure in the handle after the air is shut off without drawing the oil out of the chamber. The porous plug serves the double purpose of regulating the flow of oil and straining out any dirt or grit it may contain. A somewhat similar arrangement is used with jackhamers, but in these drills the oil chamber is placed in the side of the cylinder.

If a drill does not embody an oiling device as an integral part of its construction, it can be fitted easily with a special oiler, of which there are several types on the market. In fact, many modern drills are designed to be used with oilers of the external type.

Fig. 2 shows a satisfactory type of external oiler which embodies an oil reservoir of about a half-pint capacity. It is made of malleable iron with a taper plug valve, and is intended for use with either air- or steam-operated piston drills. The reservoir is closed with a screw plug. The taper plug has two cups on opposite sides, each holding about a teaspoonful of oil. One cup is always in communication with the reservoir and filled. A half-turn of the handle empties this cup into the supply passage to the drill, and the oil is carried as a spray into the machine. The other cup is filled ready for another turn of the handle. The reservoir holds enough oil for a half-shift's run, and the handle should be thrown about every 5 to 10 ft. of drilling. The right amount of oil is admitted each time, with no loss of oil or pressure.

Another type of oiler, Fig. 3, is designed to take the responsibility for proper drill lubrication out of the hands of the runner and place it entirely in those of the foreman. It operates by the pulsations of air in the supply pipe near the drill, due to the alternating reversals of the drill piston, and from the nature of its operation has been aptly named the "Heart Beat" oiler. It consists of an oiler body containing a plug carrying a cartridge of wire gauze and an absorbent material (Fig. 4). The body is screwed into a tee, to the branch of which the drill is connected, the oiler coming above the tee and the throttle.

The cartridges are carried in boxes. Three cartridges will suffice for one shift. The drill runner going on shift gets three cartridges from the foreman, and coming off shift, he

returns three dry cartridges, which are dropped in a tub of oil and recharged. There is no way of drying the cartridges except by using them in the drill, and the return of dry cartridges is proof the drill has been properly oiled. The oil is not wasted—blown out without doing useful work—but is fed slowly and used to best advantage.

The "Heart Beat" oiler not only enforces proper lubrication of the drill, thus reducing its wear and increasing its capacity, but also economizes lubricant. This type of oiler is intended only for use with air-operated piston drills.

Sometimes drill runners introduce oil through the hose, pouring it in before connecting the drill line to the pressure main, thereby saving themselves the trouble of unscrewing the oil plugs of the drill. This practice cannot be condemned too emphatically, for the oil rapidly destroys the rubber lining used in ordinary hose, and furthermore, it carries into the drill any particles of dirt that may have lodged in the hose.

The remaining important point to be considered in connection with lubrication pertains to grit, dirt and other foreign matter. It is scarcely necessary to mention that the working parts of the drill should be cleaned frequently, preferably with kerosene, and kept well oiled or greased while standing idle.

Dirt must be prevented from entering the drill either with the lubricant or with the compressed air. The former point is taken care of by using a good quality of liquid grease only or oil free from impurities and keeping the supply in a closed vessel. A little grit will do a lot of damage in cutting out cylinders, valves and rotation parts. Small particles of grit and dust pass through the hose, and these must be removed before entering the drill, usually, by an air strainer or filter of some type placed as close to the drill inlet as practicable.

Fig. 5 shows the details of a strainer placed within a stoping drill. This strainer consists of a cup-shaped disk of perforated metal held in position back of the throttle valve by a coiled spring. It has been objected by some that a strainer such as this will result in loss of air pressure. However, tests at various pressures have shown that no reduction in air consumption or loss of power occurs through its use. If the work done by the machine falls off, it is an indication that the strainer is clogged with dirt and needs cleaning. It will be noticed that the air inlet is enlarged at the strainer, permitting an unrestricted flow of air.

Fig. 6 shows another type of strainer, which is principally intended for use on stope drills. The straining medium consists of a piece of perforated metal rolled into the form of a tube. The connection of which this type of strainer is a part should always remain attached to the valve chest when the machine is disconnected from the pressure line to prevent dust from entering the tool while lying idle. Dirt collects on the inside of the straining tube and may be easily removed from time to time by taking the device off the drill and blowing air through it from the end opposite that into which air ordinarily enters. Fig. 7 shows a sectional view of an angle filter, which forms a part of the standard equipment of certain water drills.

The straining medium in the filter, illustrated in Fig. 7 consists of a tube of brass wire cloth through which the air must pass to enter the machine. The area through this tube is greatly in excess of the area of the inlet and outlet passages, which insures a free flow of air.—*Eng. and Min. Journal.*

## COMPRESSED AIR AS A COOLANT IN METAL CUTTING

In milling cast iron and similar operations where the production of short chips makes lubrication of the bearing between the chip and lip of the tool a matter of minor importance, satisfactory results may often be obtained by the use of compressed air delivered to the tool and work in such a way that it absorbs the heat generated by the cut. An advantage of the use of compressed air is that there is absolutely no tendency to gum, and the work is clean and dry when it leaves the machines; also, absence of moisture does away with all danger of rusting the work or machine parts. Fig. 1 shows the method of applying compressed air in milling a typewriter part in the plant of the Royal Typewriter Co., Hartford, Conn. This bar has a slot 7-32 inch wide by 13-32 inch deep milled for its entire length, which is 8¾ inches. The compressed air is delivered through an air

line arranged in such a way as to decrease the pressure at the machine to one pound per square inch. At each side of the milling cutters there are pipes A bent to the same radius as the cutters; a number of holes are drilled in these pipes, so that air impinges directly upon the milling-cutter teeth. The pressure of the air is not sufficient to cause the chips to be blown around, but the air absorbs heat from the cutters and work, preventing overheating and excessive wear. The slot is finished at a single cut by milling cutters 2¾ inches in diameter which run at 120 revolutions per minute. One piece is finished in one minute, twelve seconds. When finished the work is sufficiently cool so that it can be picked up and held in the hand.

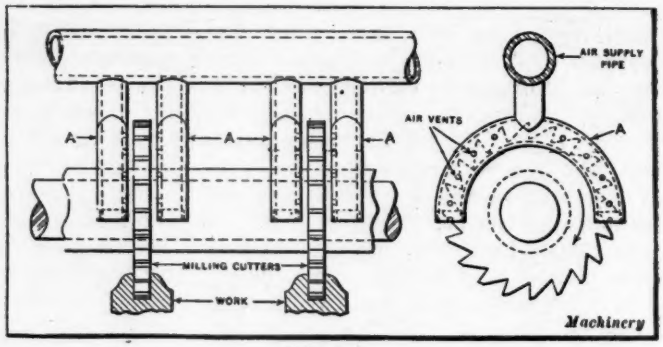



FIG. 1.

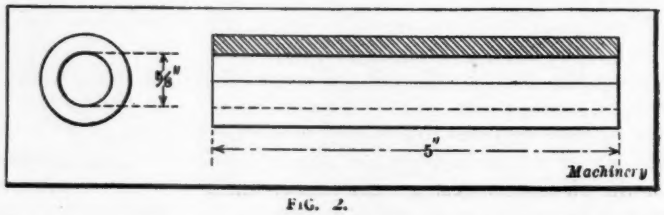



FIG. 2.

Fig. 2 shows another example of the application of compressed air for cooling cutting tools. In this case the operation is performed on a Cleveland automatic. The work is a 0.20 to 0.30 per cent carbon machine-steel piston-pin; this is of particular interest because although it is known that compressed air can be used in drilling cast iron with satisfactory results, few mechanics would expect to be able to use it in deep-hole drilling operations in machine steel. The automatic screw machine is fitted up with the regular oil-feed mechanism for the turret tools, but instead of forcing the oil through the piping, compressed air is delivered at a pressure of 75 pounds per square inch. The drill is a regular high-speed steel oil-tube type, with cutting edges ground to break up the chips so that they may be readily removed. So efficient is the compressed air that it is found unnecessary to withdraw the tool until the piece has been completely drilled to a depth of 5 inches, using a feed of 0.015 inch per revolution and a surface speed of 70 feet per minute. This speed is lower than a high speed steel drill will stand, but it has been found that a heavy feed with a lower speed gives the best results, as it produces chips which may be easily blown out. The chips are quite cool when they leave the hole and an excellent finish is produced. Before adopting compressed air, lard oil was used for this job, but this proved unsatisfactory due to heating and binding of the drill before the lubricant had reached the bottom of the hole. Apparently the oil made the chips adhere to one another and prevented them from being washed out freely, while with the air the chips are kept clean and cool and are blown out as rapidly as they are produced. This method is used at the plant of the Dayton Motor Car Company, Dayton, Ohio.—*Edward K. Hammond in Machinery.*

## COMPRESSOR UNLOADER SAVES POWER

BY C. W. HUNT, JR.

An installation which should be of interest to readers of Compressed Air Magazine is that of a 15 and 9x12 Imperial Type XB2 compressor installed at the mine of the Round Mountain Mining Company, Round Mountain, Nevada.

This machine has been in use about four years, and was at first equipped only with an inlet loader of the Imperial type. Another

compressor having been purchased with a discharge line unloader it was suggested that a discharge line unloader should be applied also to this machine. For three or four months the management objected that they did not want to go to the additional expense of $60.00. They, however, finally decided to instal the discharge line unloader in conjunction with their inlet unloader, and in the first month's operation the actual saving was $15.20.

The next month they ran one shift of 10 hours each day for 28 days in the month, and the saving in their power bill was figured out by them to be slightly over $28.00 for the month, this due entirely to the use of the discharge line unloader. If there is a better instance of money saving by a small investment in an improved appliance I do not know of it.

San Francisco, Cal.

## AIR AND HEAT FOR DRYING

BY GILBERT C. SHODWELL*

Drying is not accomplished directly by heat nor by air alone, but air is a common and convenient medium which if properly applied is capable of absorbing and conveying moisture. Air will, as we may say, dissolve water in practically the same way that water will dissolve any such substance as sugar or salt. Water at any temperature will take up only a certain amount of sugar or other solid solution. Beyond a certain point (termed the saturation point) no more sugar can be dissolved by the water if the temperature remain the same. In order to absorb more sugar or salt in the same volume of water, the temperature of the water must be raised. Moreover, the process of absorption of the sugar or salt will be materially accelerated if the water be put in motion.

There are thousands of dry rooms throughout the country which have in them gas burners, steam coils, or other sources of heat, and which have no air outlet. They are, in effect, merely sweat rooms—they are exceedingly inefficient. They only accomplish results partially and even so, take a far longer time to do this partial work than is necessary.

In some cases these sweat rooms have effected a fraction of the solution of the problem by the use of fans on the ceiling or elsewhere so as to keep the air in motion and bring about a condition somewhat analogous to the stirring of the cup of coffee with sugar in it. But it is at once apparent that these fans merely churn the air, and as all the moisture is kept in the room, that this air, without being changed, cannot be of any use for drying when once it has reached the point of saturation.

It is true that there are certain operations which demand a circulation and recirculation of the same volume of air several times through a dry room before it is finally discharged into the outside atmosphere, but the large majority of drying problems are served best by blowing properly heated air into the dry room, then bringing it into intimate contact with the products to be dried, and finally allowing it to be discharged from the room.

### DRYING AT LOW TEMPERATURE

All have noticed the ice which accumulates on the outside of the ammonia pipes in a refrigerating plant and are no doubt aware that this ice is formed from the water or moisture which is condensed from the air in the room, because its temperature has been reduced so much that it cannot retain all the moisture which it carried at the higher temperature; so dew forms on the pipes and is frozen. If air which was saturated at 32 deg. Fahr., has its temperature raised to 70 deg., it will be very dry, having a relative humidity of only about 18 per cent.

It is possible and perfectly feasible, and is moreover common practice, to accomplish drying at as low a temperature as 70 deg. Fahr. This is resorted to extensively, in the drying of products which will not stand a higher temperature, such as the drying of motion picture films, etc. In such cases the air is first of all "squeezed" dry of its moisture by means of refrigerating it and afterwards this dry air has its temperature raised to the required degree.

### AIR IS CHEAP

As a drying medium air costs nothing; 70 cu. ft. of manufactured city gas will raise the temperature of 20,000 cu. ft. of air from 70 deg. to 170 deg. Fahr., or 10,000 cu. ft. of air from 70 deg. to 270 deg. Fahr., with an air heater to

*Abstract of paper before American Society of Heating and Ventilating Engineers.

be described later. Twenty thousand cu. ft. of air at 170 deg. Fahr., if saturated, will carry away more than 25 lbs. of water; 10,000 cu. ft of air at 270 deg. Fahr., would carry away an infinite amount of moisture (because this temperature is above the boiling point of water) if the air contained sufficient heat to evaporate the water. If air with 100 per cent. humidity and at 70 deg. Fahr. be passed through this air heater so as to increase its temperature to 80 deg. Fahr., its humidity will then be reduced to less than 50 per cent. If its temperature be increased to 170 deg. Fahr., its humidity will be reduced below 0.09 per cent. This air will be very much drier than is ever found in nature and will absorb moisture very rapidly indeed.

A concrete example will illustrate this: If saturated air at say, 70 deg. Fahr. has its temperature increased only 10 deg., it can then absorb as much more water as it carried at 70 deg. and still have a humidity of less than 50 per cent. This is clearly seen from Fig. 1, which shows the quantity of moisture that one pound of air will contain when saturated at different temperatures. The hotter the air the more moisture it can carry. 10,000 cu. ft. of air at 270 deg. Fahr. contains sufficient heat to evaporate more than 50 lbs. of water, but in so doing it gives up some of its heat, bringing the air again below the boiling point of water. From this it is evident that to carry away this amount of moisture efficiently, about twice this quantity of air should be figured.

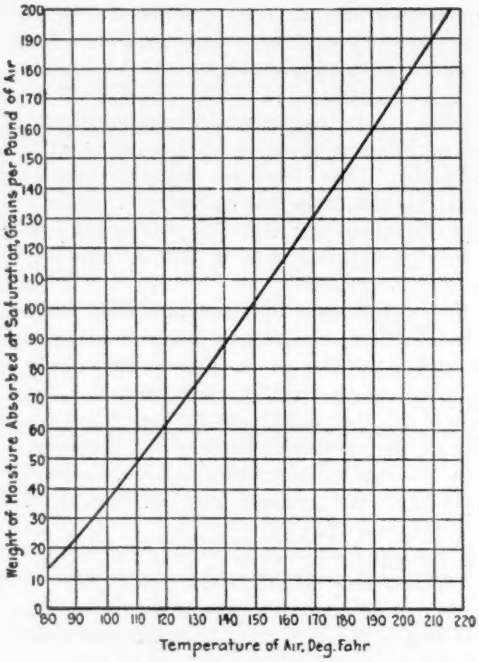



FIG. 1. MOISTURE IN ONE POUND OF AIR.

### HEATING IS NOT DRYING

An even load of lacquered or japaned goods has but an infinitesimal fraction of soluble vapor to the total of air in the oven, so that this quantity of air is well able to take care of the vapor as a rule. The heating of products in an oven such as lacquered or japanned goods is strictly a baking proposition and although they become dry, it is not the same kind of drying as takes place when wet products are dried in a dry room. Meat, bread, etc., when placed in an oven are not dried in the proper sense of the word, although they may give up some of their moisture, but the physical and chemical compositions of such products are definitely changed and we call this change "baking." It is therefore probably a confusion between the processes of baking and drying which has led many people astray.

In order to use heated air for drying so that results will be entirely satisfactory it must be heated efficiently, and this has taken many years of thought and experimentation on the part of engineers. The mere heating of air by the means previously in vogue would have been a great handicap to success owing to their inefficiency, but this has been overcome by the use of a suitable heater.

Calculation of the size of heater to use on any particular installation is very simple. Experience has shown that it is desirable to change the air in the average dry-room from two to five times per minute, and the air should be supplied at the highest temperature which the material to be dried will stand. The proper temperatures for different materials are given in Table 1. When high temperatures are used for drying, that is, temperatures above 250 deg. Fahr., the oven or dry-room must be well insulated to prevent the loss of heat through its walls.

### AIR CIRCULATION

Also the distribution of the heated air is important. It is necessary that the heated

TABLE 1. TEMPERATURES REQUIRED FOR DRYING DIFFERENT MATERIALS.

| Drying | Temperature Required (deg. fahr.) | Drying | Temperature Required (deg. fahr.) |
|---|---|---|---|
| Treated or dyed paper | 150-220 | Herbs | † |
| Glued paper | 160-300* | Barks | † |
| Glued tapes | 160-300* | Pills | † |
| Pasted ribbons | 160-200 | Furs | 150-190 |
| Printing ink | 70-300* | Size on paper | 150-220 |
| Felt Hats | 140-180 | Bedding | 150-190 |
| Glued Ladies' Hats | 140-180 | Nuts | 90-140 |
| Matches | 140-180 | Cereals | 110-150 |
| Macaroni | 110-150 | Glassware | † |
| Photo Prints | 90-110 | Hops | 120-180 |
| Photo Negatives | 90-110 | Rags | 120-180 |
| Photo Films | 90-110 | Overalls | 120-180 |
| Feathers | 150-180 | Bathing suits | 120-180 |
| Hair Goods | 150-190 | Blankets | 140-180 |
| Clothes | † | Knitted Fabrics | 140-180 |
| Drugs | † | Gut | 150-200 |
| | | etc., etc., etc. | |

*Can be dried at any temperature under 300 deg fahr., that it is convenient to use.
†Depending on nature.

air from the heater be distributed directly to the product to be dried by means of air ducts or pipes. If the air be merely blown into the dry-room, most of it will, except in rare cases, pass around the sides of the product next to the walls of the room and be wasted Great care should be used in the arrangement of the product to be dried, to see that the air will circulate through or about every particle of it; the results will repay the effort.

In calculating drying problems, if greater accuracy be required, Table 2 may be employed. Column A of the table shows the air temperatures leaving the heater to enter the dry-room; columns B and D give the greatest possible amount of moisture which can be absorbed at each temperature; columns C and F show how much air, when saturated, will take up one lb. of water.

### A PRACTICAL PROBLEM IN DRYING

Suppose blankets are to be dried, that when dry, they weigh 100 lb., and when wet, 200 lb.; the amount of water to be evap-

TABLE 2. MOISTURE REMOVING CAPACITY OF AIR

| | Entering Heater Saturated. at 70 deg. fahr. | | Entering Half-Saturated. (50% Relative Humidity) at 70 deg. fahr. | |
|---|---|---|---|---|
| A Temp. of Air entering Dry-room deg. fahr. | B Water-carrying capacity of air Grains per lb. of air | C Cu. ft. of air (at saturation) required per lb. of water vapor | D Water-carrying capacity of air Grains per lb. of air | E Cu. ft. of air (at saturation) required per lb. of water vapor |
| 80 | 11.6 | 8240 | 28.6 | 3300 |
| 90 | 23.9 | 4050 | 39.7 | 2380 |
| 100 | 36.3 | 2640 | 51.2 | 1845 |
| 110 | 48.8 | 1965 | 62.5 | 1515 |
| 120 | 61.8 | 1525 | 74.5 | 1270 |
| 130 | 74.8 | 1280 | 87.0 | 1085 |
| 140 | 87.8 | 1090 | 99.5 | 950 |
| 150 | 101.8 | 934 | 112.0 | 845 |
| 160 | 116.3 | 827 | 125.0 | 755 |
| 170 | 130.8 | 732 | 138.0 | 685 |
| 180 | 145.3 | 662 | 151.0 | 625 |
| 190 | 159.8 | 600 | 164.5 | 575 |
| 200 | 174.3 | 562 | 178.5 | 530 |

ance space, with head not jacketed, would reduce the actual amount of air lost in the clearance, and in this manner increase the volumetric efficiency.

### THE MOISTURE IN THE AIR

It is worth while to consider the question of moisture in the air as affecting power consumption and volumteric efficiency. The moisture carrying capacity of air is dependent upon and its limits are automatically determined by its pressure and its temperature, especially the latter. Pounds of water vapor in 1,000 cu. ft. of air at different temperatures and per cent. of saturation are as follows:

| | 25% | 50% | 75% | 100% |
|---|---|---|---|---|
| 100°F. | .705 | 1.411 | 2.117 | 2.823 |
| 70 | .285 | .570 | .855 | 1.140 |
| 60 | .205 | .410 | .615 | .820 |
| 50 | .145 | .291 | .436 | .582 |
| 32 | .075 | .150 | .226 | .301 |

The United States Weather Bureau records for a period of 15 years show humidity as follows. We table a number of localities to show that 100% humidity seldom occurs:

| | Humidity 8 A. M. | Humidity 8 p. m. |
|---|---|---|
| New York .... | 76% | 71% |
| Chicago ..... | 78 | 72 |
| Denver ..... | 61 | 39 |
| El Paso ..... | 53 | 26 |
| Helena ..... | 66 | 47 |
| Salt Lake City | 59 | 46 |
| Seattle ..... | 86 | 66 |
| Portland ..... | 87 | 63 |
| San Francisco. | 87 | 73 |
| Los Angeles.. | 78 | 64 |

For the convenience of the writer, with a specific case in mind, we may here consider the operating conditions for a compressor located at Salt Lake City, Utah.

Assumed average conditions for Salt Lake City locality:

Average humidity .....50%
Elevation .....5000 ft.
Atmosphere pressure .....12.14 lb.
Average temperature .....70°F

Intercooler pressure, when compressing to 100 lb. gage discharge pressure from high pressure cylinder, and if load is balanced, will be approximately 26 lb. or a little more than three atmospheres at 5,000 ft. elevation. When compressed to two atmospheres, the humidity of the reduced volume will then become 100%, and at three atmospheres, 117%. Then 17% of the entrained moisture or water vapor is ready to precipitate if the temperature of the air holding the moisture is sufficiently low. It will not precipitate, on account of its velocity through intercooler, unless the temperature has been reduced to considerably less than 70° F. and this is plainly impossible with cooling water at 50°F.

The temperature at which condensation or precipitation begins is the dew point or the saturation temperature for the given pressure. Air at atmospheric pressure, 70 F. and 100% humidity, will hold in suspension, in 1,000 cu. ft. volume, 1.14 lb. of water vapor, and no precipitation will occur unless the temperature is reduced or a reduction of volume by increased pressure causes a percentage of humidity above the point of saturation.

The claim has been made that the moisture can be *shocked* out of the air during its passage through the intercooler by moving it at high velocity against obstructions provided in the intercooler. Velocity in an intercooler can be considered in two ways only. It must be high enough to get maximum cooling due to the sweeping of the air over the tubes. It must be so low that appreciable drop in intercooler pressure does not occur. Intercoolers are now so designed and built that pressure drop, due to velocity, is kept down to 3½ in. to 4 in. water column, or 0.126 to 0.145 lb. per square inch.

Contrary to the shock idea, if compressed air just delivered from a compressor and carrying a load of condensed but not precipitated moisture, made excessive by the reduction of volume, could be kept in an unmoving mass, the moisture would slowly precipitate or fall to the bottom of the receiver as its temperature fell; but, as air is usually given no time to stop, only a small portion of its moisture is deposited in the receiver, and this only when the temperature has been reduced. The balance of the moisture is carried along and gradually deposited in the pipe line.

The moisture present in the air of course displaces a certain portion of the air, so that any given volume of air with all the moisture it can carry represents an actual quantity of air slightly less than the same volume of air

in which the humidity was comparatively low. Some enthusiasts have greatly exaggerated this and have asserted, or as least suggested, that a standard modern compressor could be improved to the point of delivering 15% to 30% more air by the removal of the moisture in it. It is true, theoretically at least, that a little more air could be put through the compressor and delivered if the moisture were abstracted from the air *before it went into the compressor,* but the increase would be only about 1% even when the humidity was as high as 100%. Careful tests have shown that when compressing air at 50% intake humidity and when the water is cool enough to precipitate 75% of the moisture in the intercooler, there is a loss in volumetric efficiency of about ½ of 1% when correction is made for humidity and temperature.

Supposing a modern two stage compressor to be running under average conditions, the only improvement it could be expected to be made would be a reduction of horse power of about 1% for each 10 degrees that the temperature of the air leaving the compressor was lowered.

With a compressor with a 200 h. p. load, allowing $25.00 per h. p. year, and with new intercooler and separator costing $500.00, it would take ten years to save enough to pay the cost of it, with no other saving whatever.

For the data and most of the arrangement of this article I am indebted to Mr. Jos. B. Mossman, of Salt Lake City, Utah.

## LUBRICATION OF ROCK DRILLS

BY CHARLES C. PHELPS

Rock drills are generally regarded as the most "rough and ready" tools in use. They can withstand almost any abuse. As a consequence many drill runners believe that any oil is good enough for lubricating a drill. While it is true that drills will run with almost any kind of oil, it is beyond question that the best results and the least repair costs are obtained only by employing lubricants especially suited to the service. For steam-operated drills a good quality heavy-body steam cylinder oil is generally found to be most suitable. For air-operated drills, the usual advice is to employ a light or medium-body oil of good quality; however, recent experiments have shown that liquid grease is much better suited for air-operated drills under many conditions of service. This lubricant has been used successfully with both hammer and piston drills, mounted and unmounted types. Liquid grease is particularly valuable for water machines, like the Leyner-Ingersoll, water jackhamer and water stopehamer, for the reason that it is not washed out by the water as readily as oil is.

Liquid grease is a substance that has the appearance of oil and flows similarly, but otherwise has the characteristics and properties of grease. It may be handled in an ordinary oil can and will flow freely through the automatic lubricators on drills. It is made by several of the oil companies. It would be impractical to list here all the various brands which are suitable for air-operated drills, but Texaco transmission grease No. 2, Polarine liquid grease, Keystone liquid grease No. 5 and No. 6 have been found to give satisfactory results.

The method of feeding is fully as important as the kind of lubricant used. Insufficient lubrication results in slower drilling speed, power wasted in friction, and a more rapid wearing out of parts with consequent higher repair expense. Lubricating too liberally simply increases the oil bill without making any appreciable gain in the operation of the drill. Too often, the matter of lubrication is left to the discretion of the drill runner, who either feeds the oil too liberally or forgets to replenish the supply until the drill runs dry and, by its poor performance, reminds him that it is time to relubricate. One of the best ways to determine whether a hammer drill is getting sufficient lubricant is to notice, when changing steels, whether the shank has oil on it. An operator soon learns to tell when a drill needs lubricant by the dry appearance of the steel shank.

The more modern drills are provided with means for automatic lubrication—features of the greatest practical value. Sometimes the oiling device is an integral part of the drill, and sometimes it is a separate part.

Fig. 1 shows the arrangement for oiling employed with a typical stoping drill. The oil well is in the handle used for rotating the stoper. The hollow handle A fits in a taper hole in the valve chest. In the handle is a porous plug C, beyond which is the oil cham-

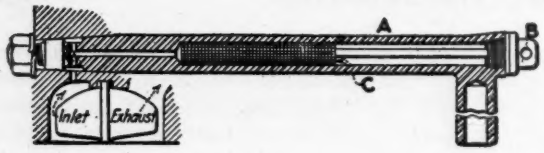



FIG. 1.

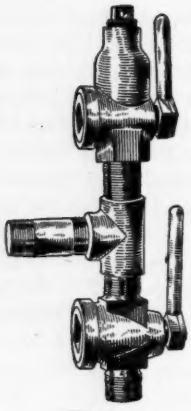


Fig. 2

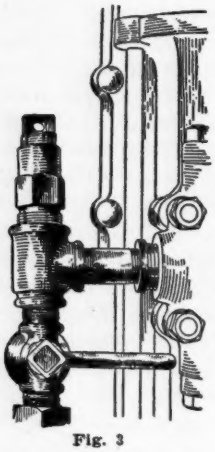


Fig. 3

Fig. 4

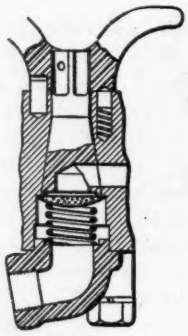


Fig. 5

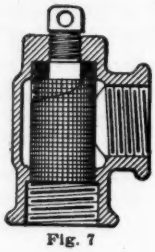
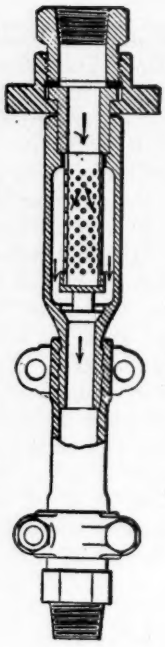


Fig. 7



ROCK DRILL LUBRICATING APPLIANCES.

ber. Before starting the machine, oil plug B is removed and the chamber in the handle filled with liquid grease. As the machine runs, the pulsations of the air in the supply chamber of the chest draw the oil through the porous plug into the machine. Means are provided to exhaust any pressure in the handle after the air is shut off without drawing the oil out of the chamber. The porous plug serves the double purpose of regulating the flow of oil and straining out any dirt or grit it may contain. A somewhat similar arrangement is used with jackhamers, but in these drills the oil chamber is placed in the side of the cylinder.

If a drill does not embody an oiling device as an integral part of its construction, it can be fitted easily with a special oiler, of which there are several types on the market. In fact, many modern drills are designed to be used with oilers of the external type.

Fig. 2 shows a satisfactory type of external oiler which embodies an oil reservoir of about a half-pint capacity. It is made of malleable iron with a taper plug valve, and is intended for use with either air- or steam-operated piston drills. The reservoir is closed with a screw plug. The taper plug has two cups on opposite sides, each holding about a teaspoonful of oil. One cup is always in communication with the reservoir and filled. A half-turn of the handle empties this cup into the supply passage to the drill, and the oil is carried as a spray into the machine. The other cup is filled ready for another turn of the handle. The reservoir holds enough oil for a half-shift's run, and the handle should be thrown about every 5 to 10 ft. of drilling. The right amount of oil is admitted each time, with no loss of oil or pressure.

Another type of oiler, Fig. 3, is designed to take the responsibility for proper drill lubrication out of the hands of the runner and place it entirely in those of the foreman. It operates by the pulsations of air in the supply pipe near the drill, due to the alternating reversals of the drill piston, and from the nature of its operation has been aptly named the "Heart Beat" oiler. It consists of an oiler body containing a plug carrying a cartridge of wire gauze and an absorbent material (Fig. 4). The body is screwed into a tee, to the branch of which the drill is connected, the oiler coming above the tee and the throttle.

The cartridges are carried in boxes. Three cartridges will suffice for one shift. The drill runner going on shift gets three cartridges from the foreman, and coming off shift, he

returns three dry cartridges, which are dropped in a tub of oil and recharged. There is no way of drying the cartridges except by using them in the drill, and the return of dry cartridges is proof the drill has been properly oiled. The oil is not wasted—blown out without doing useful work—but is fed slowly and used to best advantage.

The "Heart Beat" oiler not only enforces proper lubrication of the drill, thus reducing its wear and increasing its capacity, but also economizes lubricant. This type of oiler is intended only for use with air-operated piston drills.

Sometimes drill runners introduce oil through the hose, pouring it in before connecting the drill line to the pressure main, thereby saving themselves the trouble of unscrewing the oil plugs of the drill. This practice cannot be condemned too emphatically, for the oil rapidly destroys the rubber lining used in ordinary hose, and furthermore, it carries into the drill any particles of dirt that may have lodged in the hose.

The remaining important point to be considered in connection with lubrication pertains to grit, dirt and other foreign matter. It is scarcely necessary to mention that the working parts of the drill should be cleaned frequently, preferably with kerosene, and kept well oiled or greased while standing idle.

Dirt must be prevented from entering the drill either with the lubricant or with the compressed air. The former point is taken care of by using a good quality of liquid grease only or oil free from impurities and keeping the supply in a closed vessel. A little grit will do a lot of damage in cutting out cylinders, valves and rotation parts. Small particles of grit and dust pass through the hose, and these must be removed before entering the drill, usually, by an air strainer or filter of some type placed as close to the drill inlet as practicable.

Fig. 5 shows the details of a strainer placed within a stoping drill. This strainer consists of a cup-shaped disk of perforated metal held in position back of the throttle valve by a coiled spring. It has been objected by some that a strainer such as this will result in loss of air pressure. However, tests at various pressures have shown that no reduction in air consumption or loss of power occurs through its use. If the work done by the machine falls off, it is an indication that the strainer is clogged with dirt and needs cleaning. It will be noticed that the air inlet is enlarged at the strainer, permitting an unrestricted flow of air.

Fig. 6 shows another type of strainer, which is principally intended for use on stope drills. The straining medium consists of a piece of perforated metal rolled into the form of a tube. The connection of which this type of strainer is a part should always remain attached to the valve chest when the machine is disconnected from the pressure line to prevent dust from entering the tool while lying idle. Dirt collects on the inside of the straining tube and may be easily removed from time to time by taking the device off the drill and blowing air through it from the end opposite that into which air ordinarily enters. Fig. 7 shows a sectional view of an angle filter, which forms a part of the standard equipment of certain water drills.

The straining medium in the filter, illustrated in Fig. 7 consists of a tube of brass wire cloth through which the air must pass to enter the machine. The area through this tube is greatly in excess of the area of the inlet and outlet passages, which insures a free flow of air.—*Eng. and Min. Journal.*

## COMPRESSED AIR AS A COOLANT IN METAL CUTTING

In milling cast iron and similar operations where the production of short chips makes lubrication of the bearing between the chip and lip of the tool a matter of minor importance, satisfactory results may often be obtained by the use of compressed air delivered to the tool and work in such a way that it absorbs the heat generated by the cut. An advantage of the use of compressed air is that there is absolutely no tendency to gum, and the work is clean and dry when it leaves the machines; also, absence of moisture does away with all danger of rusting the work or machine parts. Fig. 1 shows the method of applying compressed air in milling a typewriter part in the plant of the Royal Typewriter Co., Hartford, Conn. This bar has a slot 7-32 inch wide by 13-32 inch deep milled for its entire length, which is 8¼ inches. The compressed air is delivered through an air

line arranged in such a way as to decrease the pressure at the machine to one pound per square inch. At each side of the milling cutters there are pipes A bent to the same radius as the cutters; a number of holes are drilled in these pipes, so that air impinges directly upon the milling-cutter teeth. The pressure of the air is not sufficient to cause the chips to be blown around, but the air absorbs heat from the cutters and work, preventing overheating and excessive wear. The slot is finished at a single cut by milling cutters 2¾ inches in diameter which run at 120 revolutions per minute. One piece is finished in one minute, twelve seconds. When finished the work is sufficiently cool so that it can be picked up and held in the hand.

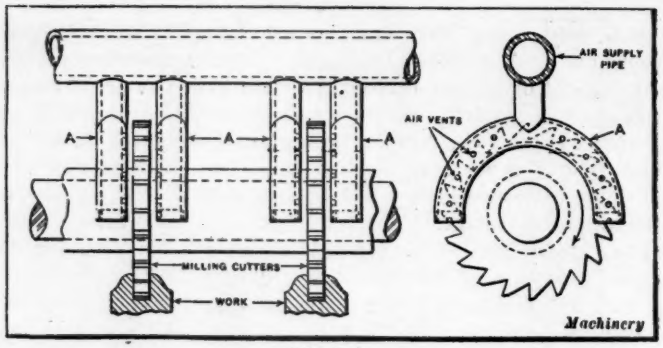



FIG. 1.

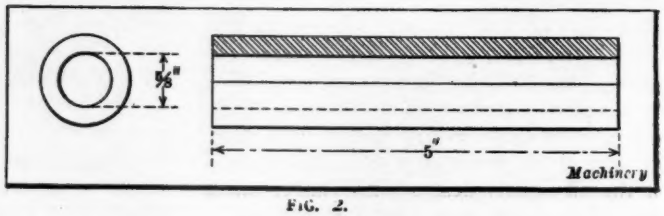



FIG. 2.

Fig. 2 shows another example of the application of compressed air for cooling cutting tools. In this case the operation is performed on a Cleveland automatic. The work is a 0.20 to 0.30 per cent carbon machine-steel piston-pin; this is of particular interest because although it is known that compressed air can be used in drilling cast iron with satisfactory results, few mechanics would expect to be able to use it in deep-hole drilling operations in machine steel. The automatic screw machine is fitted up with the regular oil-feed mechanism for the turret tools, but instead of forcing the oil through the piping, compressed air is delivered at a pressure of 75 pounds per square inch. The drill is a regular high-speed steel oil-tube type, with cutting edges ground to break up the chips so that they may be readily removed. So efficient is the compressed air that it is found unnecessary to withdraw the tool until the piece has been completely drilled to a depth of 5 inches, using a feed of 0.015 inch per revolution and a surface speed of 70 feet per minute. This speed is lower than a high speed steel drill will stand, but it has been found that a heavy feed with a lower speed gives the best results, as it produces chips which may be easily blown out. The chips are quite cool when they leave the hole and an excellent finish is produced. Before adopting compressed air, lard oil was used for this job, but this proved unsatisfactory due to heating and binding of the drill before the lubricant had reached the bottom of the hole. Apparently the oil made the chips adhere to one another and prevented them from being washed out freely, while with the air the chips are kept clean and cool and are blown out as rapidly as they are produced. This method is used at the plant of the Dayton Motor Car Company, Dayton, Ohio.—*Edward K. Hammond in Machinery.*

## COMPRESSOR UNLOADER SAVES POWER

BY C. W. HUNT, JR.

An installation which should be of interest to readers of Compressed Air Magazine is that of a 15 and 9x12 Imperial Type XB2 compressor installed at the mine of the Round Mountain Mining Company, Round Mountain, Nevada.

This machine has been in use about four years, and was at first equipped only with an inlet loader of the Imperial type. Another

compressor having been purchased with a discharge line unloader it was suggested that a discharge line unloader should be applied also to this machine. For three or four months the management objected that they did not want to go to the additional expense of $60.00. They, however, finally decided to instal the discharge line unloader in conjunction with their inlet unloader, and in the first month's operation the actual saving was $15.20.

The next month they ran one shift of 10 hours each day for 28 days in the month, and the saving in their power bill was figured out by them to be slightly over $28.00 for the month, this due entirely to the use of the discharge line unloader. If there is a better instance of money saving by a small investment in an improved appliance I do not know of it.

San Francisco, Cal.

## AIR AND HEAT FOR DRYING

BY GILBERT C. SHODWELL*

Drying is not accomplished directly by heat nor by air alone, but air is a common and convenient medium which if properly applied is capable of absorbing and conveying moisture. Air will, as we may say, dissolve water in practically the same way that water will dissolve any such substance as sugar or salt. Water at any temperature will take up only a certain amount of sugar or other solid solution. Beyond a certain point (termed the saturation point) no more sugar can be dissolved by the water if the temperature remain the same. In order to absorb more sugar or salt in the same volume of water, the temperature of the water must be raised. Moreover, the process of absorption of the sugar or salt will be materially accelerated if the water be put in motion.

There are thousands of dry rooms throughout the country which have in them gas burners, steam coils, or other sources of heat, and which have no air outlet. They are, in effect, merely sweat rooms—they are exceedingly inefficient. They only accomplish results partially and even so, take a far longer time to do this partial work than is necessary.

In some cases these sweat rooms have effected a fraction of the solution of the problem by the use of fans on the ceiling or elsewhere so as to keep the air in motion and bring about a condition somewhat analogous to the stirring of the cup of coffee with sugar in it. But it is at once apparent that these fans merely churn the air, and as all the moisture is kept in the room, that this air, without being changed, cannot be of any use for drying when once it has reached the point of saturation.

It is true that there are certain operations which demand a circulation and recirculation of the same volume of air several times through a dry room before it is finally discharged into the outside atmosphere, but the large majority of drying problems are served best by blowing properly heated air into the dry room, then bringing it into intimate contact with the products to be dried, and finally allowing it to be discharged from the room.

### DRYING AT LOW TEMPERATURE

All have noticed the ice which accumulates on the outside of the ammonia pipes in a refrigerating plant and are no doubt aware that this ice is formed from the water or moisture which is condensed from the air in the room, because its temperature has been reduced so much that it cannot retain all the moisture which it carried at the higher temperature; so dew forms on the pipes and is frozen. If air which was saturated at 32 deg. Fahr., has its temperature raised to 70 deg., it will be very dry, having a relative humidity of only about 18 per cent.

It is possible and perfectly feasible, and is moreover common practice, to accomplish drying at as low a temperature as 70 deg. Fahr. This is resorted to extensively, in the drying of products which will not stand a higher temperature, such as the drying of motion picture films, etc. In such cases the air is first of all "squeezed" dry of its moisture by means of refrigerating it and afterwards this dry air has its temperature raised to the required degree.

### AIR IS CHEAP

As a drying medium air costs nothing; 70 cu. ft. of manufactured city gas will raise the temperature of 20,000 cu. ft. of air from 70 deg. to 170 deg. Fahr., or 10,000 cu. ft. of air from 70 deg. to 270 deg. Fahr., with an air heater to

*Abstract of paper before American Society of Heating and Ventilating Engineers.

be described later. Twenty thousand cu. ft. of air at 170 deg. Fahr., if saturated, will carry away more than 25 lbs. of water; 10,000 cu. ft of air at 270 deg. Fahr., would carry away an infinite amount of moisture (because this temperature is above the boiling point of water) if the air contained sufficient heat to evaporate the water. If air with 100 per cent. humidity and at 70 deg. Fahr. be passed through this air heater so as to increase its temperature to 80 deg. Fahr., its humidity will then be reduced to less than 50 per cent. If its temperature be increased to 170 deg. Fahr., its humidity will be reduced below 0.09 per cent. This air will be very much drier than is ever found in nature and will absorb moisture very rapidly indeed.

A concrete example will illustrate this: If saturated air at say, 70 deg. Fahr. has its temperature increased only 10 deg., it can then absorb as much more water as it carried at 70 deg. and still have a humidity of less than 50 per cent. This is clearly seen from Fig. 1, which shows the quantity of moisture that one pound of air will contain when saturated at different temperatures. The hotter the air the more moisture it can carry. 10,000 cu. ft. of air at 270 deg. Fahr. contains sufficient heat to evaporate more than 50 lbs. of water, but in so doing it gives up some of its heat, bringing the air again below the boiling point of water. From this it is evident that to carry away this amount of moisture efficiently, about twice this quantity of air should be figured.

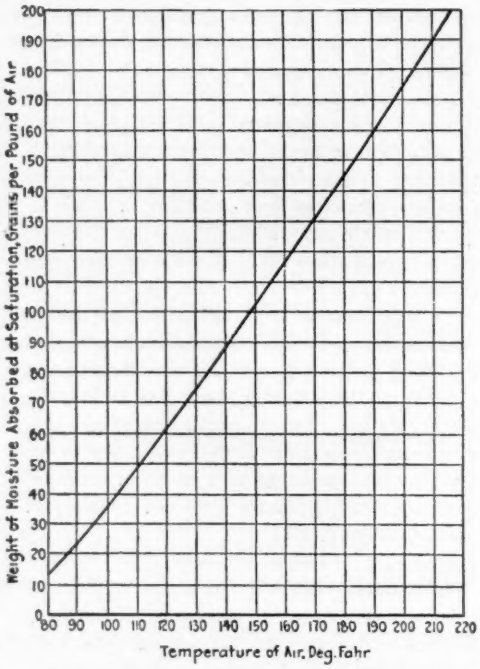



FIG. 1. MOISTURE IN ONE POUND OF AIR.

### HEATING IS NOT DRYING

An even load of lacquered or japaned goods has but an infinitesimal fraction of soluble vapor to the total of air in the oven, so that this quantity of air is well able to take care of the vapor as a rule. The heating of products in an oven such as lacquered or japanned goods is strictly a baking proposition and although they become dry, it is not the same kind of drying as takes place when wet products are dried in a dry room. Meat, bread, etc., when placed in an oven are not dried in the proper sense of the word, although they may give up some of their moisture, but the physical and chemical compositions of such products are definitely changed and we call this change "baking." It is therefore probably a confusion between the processes of baking and drying which has led many people astray.

In order to use heated air for drying so that results will be entirely satisfactory it must be heated efficiently, and this has taken many years of thought and experimentation on the part of engineers. The mere heating of air by the means previously in vogue would have been a great handicap to success owing to their inefficiency, but this has been overcome by the use of a suitable heater.

Calculation of the size of heater to use on any particular installation is very simple. Experience has shown that it is desirable to change the air in the average dry-room from two to five times per minute, and the air should be supplied at the highest temperature which the material to be dried will stand. The proper temperatures for different materials are given in Table 1. When high temperatures are used for drying, that is, temperatures above 250 deg. Fahr., the oven or dry-room must be well insulated to prevent the loss of heat through its walls.

### AIR CIRCULATION

Also the distribution of the heated air is important. It is necessary that the heated

TABLE 1. TEMPERATURES REQUIRED FOR DRYING DIFFERENT MATERIALS.

| Drying | Temperature Required (deg. fahr.) | Drying | Temperature Required (deg. fahr.) |
|---|---|---|---|
| Treated or dyed paper | 150-220 | Herbs | † |
| Glued paper | 160-300* | Barks | † |
| Glued tapes | 160-300* | Pills | † |
| Pasted ribbons | 160-200 | Furs | 150-190 |
| Printing ink | 70-300* | Size on paper | 150-220 |
| Felt Hats | 140-180 | Bedding | 150-190 |
| Glued Ladies' Hats | 140-180 | Nuts | 90-140 |
| Matches | 140-180 | Cereals | 110-150 |
| Macaroni | 110-150 | Glassware | † |
| Photo Prints | 90-110 | Hops | 120-180 |
| Photo Negatives | 90-110 | Rags | 120-180 |
| Photo Films | 90-110 | Overalls | 120-180 |
| Feathers | 150-180 | Bathing suits | 120-180 |
| Hair Goods | 150-190 | Blankets | 140-180 |
| Clothes | † | Knitted Fabrics | 140-180 |
| Drugs | † | Gut | 150-200 |
| | | etc., etc., etc. | |

*Can be dried at any temperature under 300 deg fahr., that it is convenient to use.
†Depending on nature.

air from the heater be distributed directly to the product to be dried by means of air ducts or pipes. If the air be merely blown into the dry-room, most of it will, except in rare cases, pass around the sides of the product next to the walls of the room and be wasted Great care should be used in the arrangement of the product to be dried, to see that the air will circulate through or about every particle of it; the results will repay the effort.

In calculating drying problems, if greater accuracy be required, Table 2 may be employed. Column A of the table shows the air temperatures leaving the heater to enter the dry-room; columns B and D give the greatest possible amount of moisture which can be absorbed at each temperature; columns C and F show how much air, when saturated, will take up one lb. of water.

### A PRACTICAL PROBLEM IN DRYING

Suppose blankets are to be dried, that when dry, they weigh 100 lb., and when wet, 200 lb.; the amount of water to be evap-

TABLE 2. MOISTURE REMOVING CAPACITY OF AIR

| | Entering Heater Saturated. at 70 deg. fahr. | | Entering Half-Saturated. (50% Relative Humidity) at 70 deg. fahr. | |
|---|---|---|---|---|
| A Temp. of Air entering Dry-room deg. fahr. | B Water-carrying capacity of air Grains per lb. of air | C Cu. ft. of air (at saturation) required per lb. of water vapor | D Water-carrying capacity of air Grains per lb. of air | E Cu. ft. of air (at saturation) required per lb. of water vapor |
| 80 | 11.6 | 8240 | 28.6 | 3300 |
| 90 | 23.9 | 4050 | 39.7 | 2380 |
| 100 | 36.3 | 2640 | 51.2 | 1845 |
| 110 | 48.8 | 1965 | 62.5 | 1515 |
| 120 | 61.8 | 1525 | 74.5 | 1270 |
| 130 | 74.8 | 1280 | 87.0 | 1085 |
| 140 | 87.8 | 1090 | 99.5 | 950 |
| 150 | 101.8 | 934 | 112.0 | 845 |
| 160 | 116.3 | 827 | 125.0 | 755 |
| 170 | 130.8 | 732 | 138.0 | 685 |
| 180 | 145.3 | 662 | 151.0 | 625 |
| 190 | 159.8 | 600 | 164.5 | 575 |
| 200 | 174.3 | 562 | 178.5 | 530 |

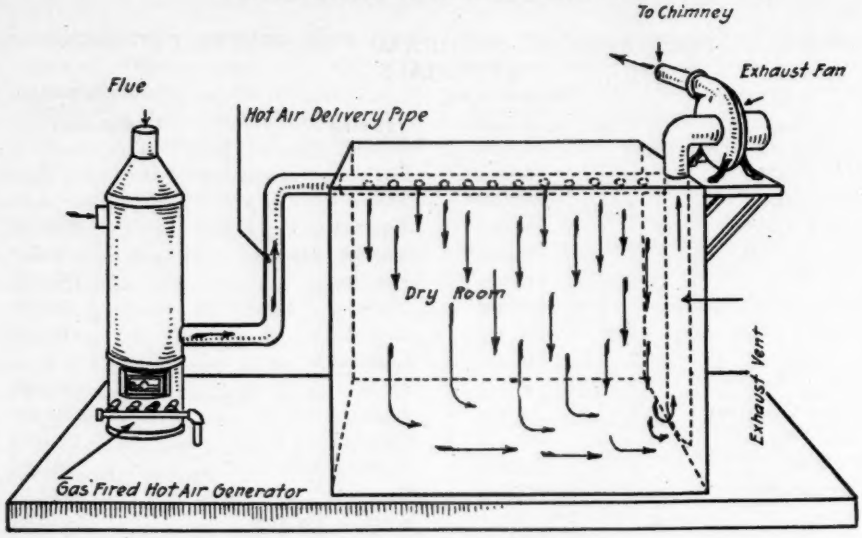



FIG. 2. DRYING BY BLOWING AIR.

orated will then be 100 lb. Assume the dry-room to be 7 by 5 by 10 ft., or 350 cu. ft., that the air enters it at 140 deg. fahr., and the number of cubic feet of heated air per hour at that temperature to be 38,500 with a small heater. We find from column C, Table 2, that 1,090 cu. ft. of air are required per pound of water. Thus for 100 lb. of water, 109,000 cu. ft. would be required. Hence the time taken, theoretically, to dry the blankets would be $\frac{109000}{38500}$ hours, or about 170 minutes, if the "used" air be saturated. In practice, the air will not become saturated so this time should be doubled. A large heater, which has double the capacity of the small, will do the same work in half the time or twice the work in the same time. It is interesting to note that this method of calculation checks up with the first method. Thus: 109,000 cu. ft. in 170 minutes, is equal to about 650 cu. ft. per minute. The heater has a capacity of about 650 cu. ft. per minute. The dry-room has a volume of 350 cu. ft., which thus allows about two changes of air per minute; or, with the great-

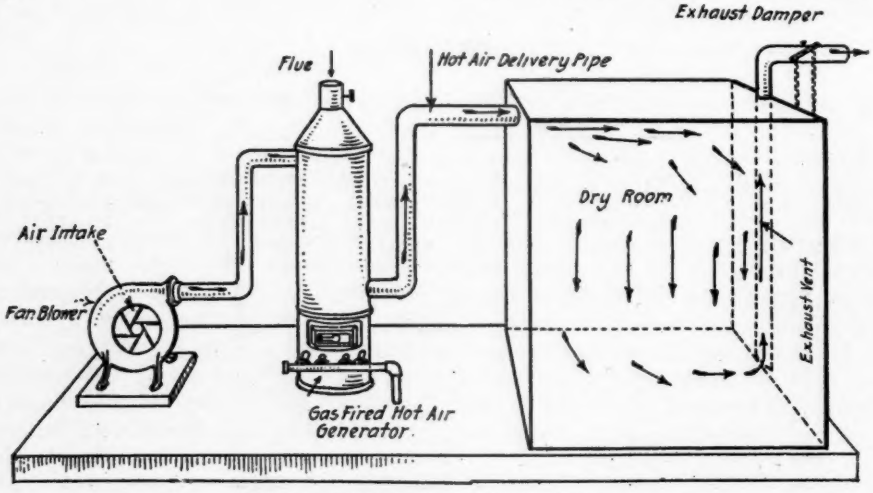



FIG. 3. DRYING BY EXHAUSTING AIR.

er allowance advised as a "factor of safety" and if the air were doubled, there would be 3½ to 4 changes of air per minute, which checks with the estimate of 2 to 5 changes per minute previously made.

To calculate the volume of air at any gas consumption other than the maximum, the following formula may be used:

$$C = \frac{E}{A_3} \times B \times G \times K.$$

Where C=Capacity in column F;
E=Value shown in column E;
$A_3$=Value shown in column $A_3$;
B=B.t.u. per cu. ft. of gas;
G=Gas consumption in cu. ft. per hr.;
K=A constant depending on the efficiency which is high at low temperatures and gradually falls from 90 per cent. at 80 deg. Fahr. to 75 per cent. at 300 deg. Fahr. 80 per cent. is a fair average. Therefore, use K as 0.8.

EFFICIENCY OF HEATED AIR

Heated air in motion is the cheapest and most efficient drying medium; it will absorb any kind of moisture, vapors, or gases. The effect of the weather on this method is negligible; it can be used all day and every day. Cold, natural air, even on a fine day, takes from six to thirty times as long as air supplied this way; it will accomplish in a day what would take a week by ordinary drying methods. Most important is the absolute temperature control easily maintained with this system of drying. From Table 2 it is evident that the drying temperature may vary considerably for the same substance.

It is possible to deliver the heated air so that it may be used for drying products in the dry room which will materially affect the rate of drying. For instance, if blankets or other goods be placed in a heap on the floor, so that air cannot reach the innermost parts, their drying may be a matter of hours instead of minutes.

Figs. 2 and 3 give a diagrammatic representation of the methods of connecting an air heater with a drying room, first, by blowing the air through, and second, by exhausting it.

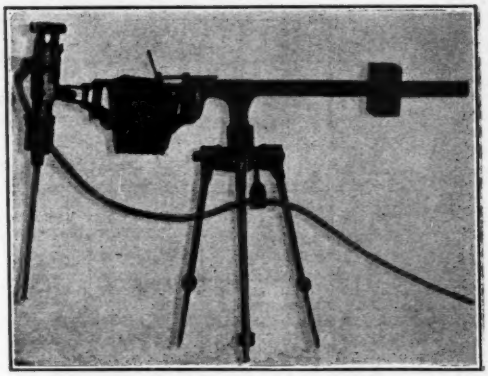


FIG. 1.

## COUNTERBALANCED HAMMER DRILL HOLDER

The two little half tones on this page tell quite clearly the story of a novel drill mounting recently put on the market by the Jackson, Schmitz & Shanks Engineering Company, Chicago. The holder is designed to hold any of the standard pneumatic tools weighing from 20 to 150 lb. It is quickly adjusted by the workmen to suit a wide variety of conditions, and when the arm is fully extended as in Fig. 2, there is an operating range of 16 ft. without shifting.

The device is shown here as of general interest to our readers and for whatever it may be worth in practice. It can scarcely fail to be noticed that with it in use the hammer drill ceases to be an instantly portable one-man tool, although there might be conditions which would favor its employment.

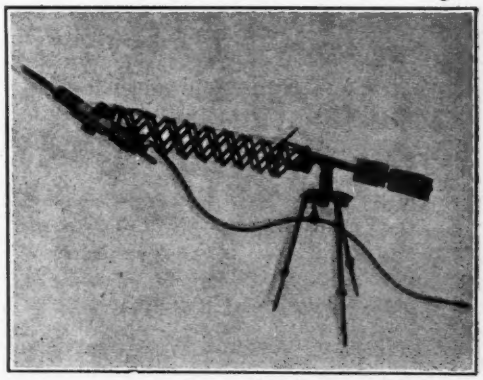


FIG. 2.

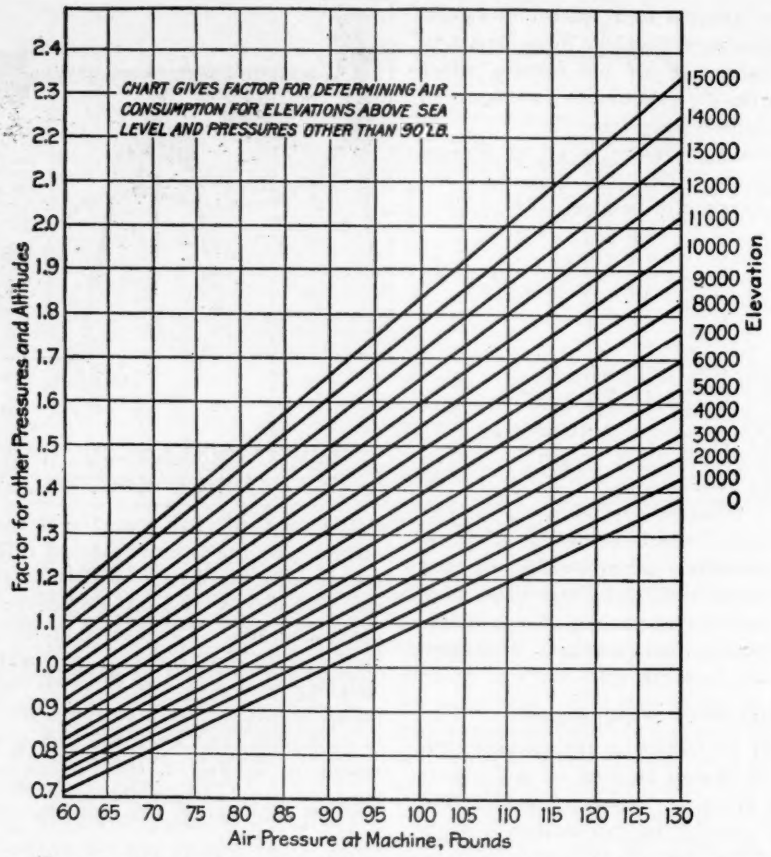



CHART FOR FINDING FACTORS FOR AIR CONSUMPTION OF DRILLS

## CHART FOR FINDING AIR CONSUMPTION OF DRILLS

BY ROBERT S. LEWIS*

The accompanying chart is a modification of the one appearing in "Rock Drilling," by Dana and Saunders, with the addition of data for hammer drills and basing the diagram on an air pressure of 90 lb. per sq. in. at the drill instead of 75 lb., to conform more nearly with the requirements of modern practice.

The inclined lines are based on a sea-level datum and 90 lb. pressure per sq. in. at the drill. This gives a factor of 1; for any other altitude or pressure at drill, the factor is found at the left margin, passing there from the intersection of the inclined line of the given altitude with a vertical through the given pressure.

The average consumption of air for both piston and hammer drills is given in Table 1. Hammer drills vary so in air consumption that only general figures can be given. Catalogs from drill manufacturers will give the consumption for any particular drill, and generally at 90 lb. pressure and at sea level. By means of the chart the consumption for other conditions can be quickly found.

In case more than one drill is used, the factor by which to multiply the air consumption of one drill to determine the consumption of a number is to be taken from Table 2. This is based on manufacturers' statements. When a number are working, they are seldom all running at the same time. This table covers the requirements from one to sixty drills.—*Eng. and Min. Journal.*

*Associate professor of mining, University of Utah, Salt Lake City, Utah.

TABLE 1. AIR CONSUMPTION OF ROCK DRILLS, CU.FT. PER MIN.

90 Lb. at Sea Level. Piston Drills

| Drills, in... | 2 | 2½ | 2¼ | 2⅝ | 2¾ | 3 | 3¼ | 3½ | 3⅝ | 4¼ | 5 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Cu.ft..... | 68 | 87 | 92 | 98 | 118 | 125 | 129 | 136 | 161 | 210 | 250 |

90 Lb. at Sea Level. Hammer Drills

| Stopers | Drifters | Sinkers | Block Holing | Hitch Cutters |
|---|---|---|---|---|
| 48–55–58 | 40–60 | 38–60 | 25–30 | 15–25 |

TABLE 2. AIR CONSUMPTION FOR MORE THAN ONE DRILL

| No. of Drills... | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Factor..... | 1.0 | 1.8 | 2.7 | 3.4 | 4.1 | 4.8 | 5.5 | 6.1 | 6.7 | 7.3 |
| No. of Drills... | 11 | 12 | 15 | 20 | 25 | 30 | 35 | 40 | 50 | 60 |
| Factor..... | 7.8 | 8.4 | 10.3 | 12.8 | 15.1 | 17.3 | 19.7 | 22.0 | 26.5 | 30.5 |

## MINE UNWATERING WITH AIR LIFT

BY S. H. BROCKUNLER

The unwatering of the Herman mine at Westville, Calif., recently accomplished, presented some unusual features. The large pump had been submerged through the carelessness of a foreman, and the small pumps, while efficient, were not capable of handling the water rapidly. It was therefore decided to try air lifts.

The shaft was inclined at an angle of 52 deg., and was 400 ft. deep. When the mine was closed down, three years before, 256 ft. of 4-in. air column was left in the shaft, with the expectation of using it for air to run the pumps and drills at a higher level. The lower end was therefore closed, but water leaked in and the column was found full.

It was decided to use this air pipe for the lift, but before doing so it was necessary to shoot the lower end off and this involved several nice problems. The length of the column was first carefully measured by weighting a steel tape and lowering it within the column. It was then calculated where a shot should be placed to come midway between the wall plates of the shaft, near the bottom of the pipe, so that it would not disturb the timbers.

The cartridge was prepared by binding four sticks of 40% dynamite tightly together, priming it with two electric detonators, attaching their terminals to No. 18 insulated copper wire, carefully binding the connections with water-proof tape and daubing the latter with pitch. In order to use the insulated wire for lowering the cartridge, as well as for firing it, a half-hitch was made with the wires around the cartridge, securing them firmly, so that there would be no pull on the detonators. The cartridge was weighted by attaching to it a piece of 1-in. pipe cut to such a length that it would support the cartridge at the place, above the bottom of the column, where it was desired the explosion should occur.

The preliminary tests were made with the insulated wire and detonators by firing a pair of detonators under water, after a submergence of half an hour, when it was found that it took six ordinary dry cells connected in series to get good results. When everything was ready, the cartridge was lowered nearly to the bottom of the column before meeting an obstruction—a tee, as was afterward found. If it had not been for the pipe weight, the work would have been held up at that point, but by gently raising and lowering the cartridge, the pipe finally guided it by the obstruction and landed firmly on the bottom, as was shown by a mark previously measured off on the conducting wires. Several hundred feet more wire was then run off and connected to one terminal of the batteries; it was then a simple thing to fire the cartridge by touching the other terminal of the batteries to the remaining conducting wire. Subsequent unwatering showed that the column had been cut cleanly at the exact point desired.

The factors for the air lift were now: 5000 ft. elevation, compressor capacity 1250 cu. ft. free air per minute compressed to 100 lb., 253 ft. of 4-in. pipe in shaft at slope of 52° giving a vertical head of 199 ft. From these data it was decided that a 1½-in. air pipe within the column would furnish sufficient air to lower the water to the second level, at 164 ft., starting with a submergence of 100% and stopping with a submergence of 33%. As a matter of fact the air lift began to balk at 40% submergence, and failed to unwater as far as the station by 20 ft., thus necessitating the lowering of the air lift to reach it.

A pump head was made by grinding down a 1½-in. return elbow until it would slide inside the 4-in. pipe. To one side of this was screwed the 1½-in. air pipe and to the other side a 1½-in. nipple 9 in. long. On the upper end of this nipple was screwed a cap perforated with 3-16 in. holes, to act as the air vent for the lift. This pump head, with air pipe attached, was then lowered inside the 4-in. pipe to near its bottom, and the air turned on, with the usual result of inexperience—too much air used, resulting in shower baths for onlookers. However, the flow of air was soon regulated and the water flow for several weeks, night and day, averaged 180 gal. per min., as measured over a dam. Subsequently, two additional lifts were put in, consisting of 2-in. pipe with side inlets, of 1-in. pipe with ¾-in. nozzles. These delivered 40 gal. per min. each. All failed below 40% submergence.

The consumption of air and power to operate these lifts was much higher than the theoretical figures, but this is partly explained by a break that was found in the large water column after unwatering. After reaching a depth of 164 ft. the remainder of the unwatering had to be done by pumps. This was much slower, even with the smaller amount of water contained in the lower workings.

It is uncertain whether the shot caused the break in the column, two lengths above the location of the shot, or whether it was there before. The air could be heard bubbling up, but the trouble could not be located. If anyone should repeat this experience and hear air bubbling or boiling in the mine, our advice is to first locate the break by raising and then lowering the air pipe within the column and listening to the sound. If the break is too far up, it will be best to bandon the fixed column if possible and lower another. This would be rather a difficult job in an inclined shaft full of wreckage of stulls and timbers, but by careful manipulation and using a large wooden cone attached to the lower end of the column, it might be accomplished.

It was expected to submit careful tests of power and air consumed, but the break of the main column rendered these useless for comparison with normal working conditions. But even with these unfavorable circumstances six weeks' time was saved and the cost was $1,330 less than it would have been had the pumps available been used—judging by their expense and rate of work when they were used after abandoning the air lifts.—*Eng. and Min. Journal.*

## PREVENTING WEEDS ON RAILROAD TRACKS

The following is furnished by a correspondent as supplementary to a question and answer on the above topic which appeared in a recent issue of *The Sun*, New York. You say, he says, that you have not heard of anything being used specifically to keep grass and weeds from sprouting in and along railroad tracks. Our latest equipment for this purpose used in our steam railroad work is capable of treating over a hundred miles of track a day. The makeup of the train is six tank cars, engine and box car, and a flat car in front. In the tank car immediately back of the flat car we carry a concentrated chemical. We pump an equal amount of concentrated chemical from this car to each of the other four tank cars, filling each car with water and then agitating the mixture by perforated pipes inside of each car and attached to an auxiliary air compressor on the engine. The flat car is equipped with a large gasolene motor connected to a centrifugal pump, which is used to pump the solution forward from the four mixing cars and sprayed out from perforated pipes. The pipes are sectional and are controlled by levers, enabling the application superintendent to sprinkle only between the rails, to the tie ends on one side or beyond the tie ends to the shoulder on one side, or entirely across from shoulder to shoulder, according to the vegetation and the way it is distributed.

Our method of track weeding has been used by over fifty railroads and traction companies all over the country for the past five years. Last year we treated over 3,500 miles of track for such roads as the Southern Railway, Seaboard Air Line, Chicago and Northwestern, Rock Island Lines, Toledo and Ohio Central (New York Central Lines), Oregon, Washington Railroad and Navigation Company, Sunset Central, Erie Railroad and the Pennsylvania Railroad, besides a great number of electric railways.

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## THE HUMIDITY PROBLEM

It is much to be regretted that we have not an instrument as handy and as readily readable as the thermometer and as well adapted for familiar popular use for the measuring of the humidity of the atmosphere, especially in living apartments and also in offices and factories and schools where so many of our waking hours are spent. As it is we suffer in health in comfort and in efficiency from humidity in summer and from aridity in winter, and while in these latter days there is more or less writing and talking about the matter little is being done toward the artificial control and correcting of the humidity of the atmosphere in which we pass our days and nights. Probably few realize how bad the conditions really are and probably they are no where worse than in the United States.

A recent issue of U. S. Public Health Reports tells of some observations made and the relative humidity of indoor and outdoor air in the winter time. It was found over a period of forty days of typical winter weather in a steam heated, well ventilated office kept at a temperature slightly above 70 deg. F., that the average indoor relative humidity was 23%. Observations also showed that this is about the humidity of the steam heated houses of the ordinary city of the North. The curious and the surprising thing is that this percentage of humidity is just the same as that observed in Death Valley, California, in the summer time.

There would seem to be little reason to wonder that diseases of the respiratory organs are all too common and only too fatal under these conditions. Arrangements should be carefully made—but where are they so made?—to prevent such extreme aridity in living rooms or the lungs lose most of their power to protect themselves against disease.

As to the excessive dryness of the air in our apartments in winter by artificial heating there is not much choice in the means employed, and ventilation, so-called, cannot efficiently help the matter. The average outdoor humidity on the days when the above indoor observations were made was 82%. Now if this outdoor air, with moisture somewhat in excess of the requirements for health and comfort, were merely heated to the indoor temperature without abstracting a par-

ticle of its moisture, it would show a relative humidity about as above reported. The apartments or offices spoken of above were steam heated, which means that there were radiators or systems of steam pipes internally heated by the steam and radiating heat from their external surfaces but contributing not a drop of water to the air. Steam heating by actually discharging clean steam into the air would be a very different proposition, but who ever does this, and why not?

There can be no perfect way of artificially correcting atmospheric humidity for indoor health and comfort except by actual transfer of sufficient moisture, putting some into the air in winter or abstracting some in the height of summer. The necessary arrangements would cost something, but would still be a bargain.

## COMPRESSED AIR AND LEGISLATION

It is considerably embarrassing and far from promising of good results to be in a position which urges to action but which does not suggest what to do or how to do it. Judging by the achievements of various legislative bodies in the enactment of so-called laws for the regulation of compressed air practice and for the inspection of compressed air apparatus, they must have been tangled up in the quandaries here suggested.

It is well known that, very infrequently, air receivers explode, and sometimes with disastrous or fatal result. It is not so generally recognized that there are two distinct classes of such explosions. In the first of these, due to dead pressure and to the lack, at the moment, of sufficient opposing strength of material, the explosion which results is not at all comparable in destructive effect to that of a steam boiler, on account of the absence of the heat reserve of the body of water and the instantamous steam generating action accompanying the sudden release of pressure, so that the stringent regulations of the steam boiler code are unnecessary and unjust.

Explosions which may here be designated as of the second class are those in which an explosive mixture of air and of volatilized inflammable constituents of the lubricating oils is formed and by some means ignited. The force which may possibly be developed under these conditions is such that no safety valves and no ordinary strength of materials are sufficient to guarantee safety, and the most exacting boiler code does not meet the case. The legislation on record seems to justly and adequately deal with neither class of compressed air dangers.

The regulations relating to the safety of workers in compressed air in subaqueous tunnels and pneumatic caissons are editorially criticized in *Engineering Record,* March 10, as follows:

While it is undoubtedly to the pecuniary advantage of the "sandhog" to implant in the mind of the general public the idea that the personal risk involved in his calling greatly increases, and that hours of work should be shortened and pay increased for every five or six pounds increase in pressure above 22 lb. to the square inch, it is nevertheless a demonstrated fact that such is not the case. Notwithstanding that the best engineering authorities were aware of the real nature of the risks to men working in compressed air work prior to 1909, the New York State legislature in that year enacted a law embodying provisions for decreasing the working time until a point was reached at 50 lb., where the men spent as much or more time getting into and out of the air chamber as they spent at work. And now Pennsylvania is reported to be considering a similar law.

Contractors in New York State have not seriously protested against this law, because it places all of them on the same footing. Nevertheless the law, which contains several inconsistencies, has increased the cost of compressed-air work in that state, and is now in a fair way to be copied by another important state.

The best authorities on the subject of caisson disease assign as the cause of the disease the liberation of bubbles of nitrogen in the blood and tissues of the body during and after decompression. Since it has been demonstrated that the blood and tissues will dissolve nitrogen at the pressures encountered in compressed air work to 75 or 80 per cent. of complete saturation within a short period after entering the working chamber, it is evident that the argument in favor of short working periods, unless these periods could be made actually shorter than 45 minutes, is

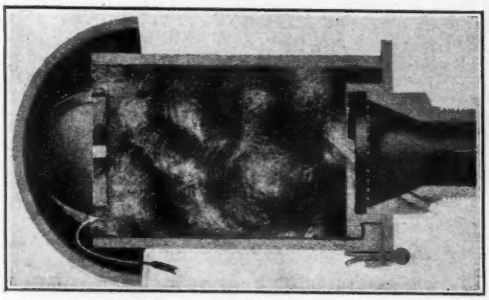
groundless. It is well understood that, unless poisonous gases are encountered, the chief danger of attack from caisson disease lies in decompression. Therefore it is doubtful whether, except for very high pressure, it does not actually increase the risk of inducing sickness to decompress the workmen from working to normal pressure twice daily instead of once daily.

Perhaps because the matter is much easier to arrange in tunnel work by reason of the space available in large tunnel bulkheads for additional locks, the New York law prescribes a much slower rate of decompression for tunnel workers than for caisson workers. The only argument in favor of this discrimination against tunnel work is that a caisson starts off at low pressure, the men working in it becoming gradually accustomed to the higher pressures and working under them in any one caisson only a few days. On the other hand, working conditions in caissons are usually considered more severe than in tunnels. It would, therefore, seem that a law which prescribed decompression for tunnel workers at the rate of 1 lb. per minute, while providing for decompression of caisson workers from given working pressures in definite intervals of so many minutes at much more rapid rates, is at least not based on scientific knowledge.

Another feature of this law that is detrimental to the safety of the workmen is that its wording definitely forbids stage decompression. In coming out of compressed air, it has been proved that the practice of reducing the air pressure rapidly to a point 20 lb. or more below the blood pressure will not give rise to the liberation of bubbles in the blood and tissues or to the symptoms of caisson disease. The law should permit stage decompression, known to be the safest method of bringing men out of compressed air, by stating that decompression should take a total time equivalent to a uniform reduction of 1 lb. per minute.

Before the New York law was enacted it was proved on the Pennsylvania tunnels under the East River that no valid argument based on additional safety to workmen can be made for decreasing the daily working period below 8 hours until a pressure of 32 lb. has been reached. Above this pressure, but below 42 lb. per square inch, the "sandhogs" on this contract worked 6 hours out of every 24, while above 42 lb. they worked 4 hours out of every 24. These working periods are much longer than those prescribed in the New York law, but it is a well-known fact that the work was carried out with a rate of sickness and death which is unusually low for such construction in New York City.

While these things are known to engineers familiar with work in compressed air, they are not known to legislators. The Pennsylvania legislature, which, it is understood, has in committee a bill similar to the New York law, should be informed on this subject by engineers before this bill can be enacted into a harmful statute. At least, those engaged in construction requiring the use of compressed air in caissons and tunnels should not sit by and allow the general public to gain the impression that the New York law and the law proposed in Pennsylvania represent the last word in safety practice for compressed-air workers when some of the provisions of these laws are actually more dangerous to workers than accepted engineering practice.



## STRAINER FOR COMPRESSOR INTAKE AIR

The air filter or strainer shown in the halftone above is made by the Gustino Bacon Manufacturing Company, Kansas City, Mo., and is normally designed for air brake pumps on locomotives. It is made of malleable iron with either 1½ in. or 2 in. fittings, and weighs 8½ lb. It may be applied to the intake pipe of the air compressor in either a horizontal or a vertical position.

It consists of a 6 in. by 4 in. cylinder filled with oil-soaked curled hair through which the air must pass before it enters the compressor cylinder, thus cleaning the air of foreign matter. The strainer, as will be seen, is

provided with a hemispherical hood which overhangs the outer wall of the cylinder for an inch or more, so that the air is drawn from inside the hood and not directly into the strainer. This construction prevents rain or snow from getting into the strainer and finally working into the cylinder. It also prevents the possibility of squirting oil into the compressor, a practice that is becoming too common with enginemen. The curled hair being soaked with oil will prevent the strainer from freezing in cold weather.

## COST OF OXY-ACETYLENE WELDING OF PIPE JOINTS

Welded pipe joints are now so generally adopted and so economical and satisfactory for the transmission of service gas that we should be hearing also of their being used for compressed air line piping. The data following, embodying the most necessary details of information concerning them have been compiled by Mr. Chester Wilde, Engineer of Mains of the Philadelphia & Suburban Gas and Electric Company, Chester, Pa.

The joints spoken of are differently designated as requiring different times and different labor costs for their completion. The ditch joint is one made in the trench; the stationary joint one made above the trench, but without turning the pipe; and the turning joint the one made with the pipe being turned in order to bring the joint to the most convenient point for the operator.

A turning welded joint on an 8-in. pipe may be made in some instances in 20 minutes or it may take as long as 35 minutes, and yet there would be no difference in strength or in its quality as a gas-tight joint. This difference of time may be caused either by the chamber on the ends of the pipe being very uneven, or possibly due to one or the other of the ends of the pipe which is being welded having for a portion of its circumference an extra thickness of metal.

First, considering an average joint, and taking into consideration only the actual time necessary to make it, the cost will be:

| | |
|---|---|
| Labor (including operator and helper) | $0.23 |
| Acetylene | .38 |
| Oxygen | .42 |
| Filling iron | 07 |
| Total cost per joint | $1.10 |

or a total per foot of pipe laid (20-ft. lengths) of 5.5 ct.

The above cost being only for the actual time found necessary to make the joint, it will be obvious that, in order to arrive at a more clear understanding of the cost of the weld, the full cost or the time of the operator and helper in other work, such as setting the pipe for the joint, changing tanks, necessary in connection with the actual welding, should be added. This additional charge will increase the labor cost from 23 ct. to 41 ct., making the total cost of the joint $1.28 and the cost per foot of main laid 6.4 ct.

Still further considering the cost in addition to the labor cost necessary for the actual welding, add the labor cost found necessary when laying a main of the size being considered (8 in.) to place the pipe in position for the welder and helper, it will be found that there will be an additional labor cost of 18 ct. per joint, making the total cost of the joint $1.47, or a cost per foot of main laid of 7.3 ct.

The above costs were calculated from 327 joints made by three welders working ahead of the ditch.

Considering now the ditch and stationary joints, it would be found, if the maximum cost of these were taken, that in some instances they would be as high as three times that of the turning joint, depending upon the condition under which it is found necessary for the operator to work. First, considering the ditch joint, the average cost will be about as follows:

| | |
|---|---|
| Labor | $0.45 |
| Acetylene | 1.06 |
| Oxygen | 1.20 |
| Filling iron | .10 |
| Total cost per joint | $2.81 |

The stationary joint will be found to cost somewhat less than the above and will aver- about as follows:

| | |
|---|---|
| Labor | $0.30 |
| Acetylene | .84 |
| Oxygen | .96 |
| Filling iron | .10 |
| Total cost per joint | $2.20 |

From a careful study of these figures it will be at once apparent that every effort should be made to avoid these latter joints, as al-

ready shown, wherever possible. The joint in the ditch should only be resorted to when an obstruction compels its use. It will be found in the case of the stationary joint that an average of about fourteen men will be required for each mile of main laid. If good judgment is used and these expensive joints kept to a minimum, the average cost per joint or per foot of main laid will only be slightly increased.

Some engineers have thought that the extra cost of labor for handling the 40-ft. lengths of pipe would more than offset any saving which might be effected due to the reduction in the number of joints made per foot of main laid.

In order to arrive at an intelligent understanding on this subject, the average cost of 128 joints, or practically a mile of 8-in. main, using 40-ft. lengths, was calculated. The average cost, including all labor necessary, in addition to the operator and helper, for shifting the pipe ahead of the welders, showed as follows:

| | |
|---|---|
| Labor | $0.95 |
| Acetylene | .38 |
| Oxygen | .42 |
| Welding iron | .07 |
| Total cost per joint | $1.82 |
| Total cost per foot of pipe laid | $0.045 |

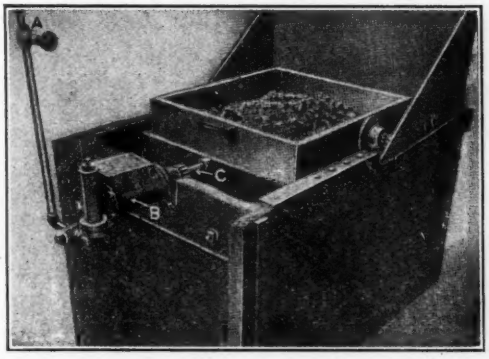
Thus it will be seen, by a reference to the maximum cost of a joint made when using 20-ft. lengths under the same conditions, the cost will be 35 ct. less than the joint of the 40-ft. lengths, but that the latter has a much less cost per foot of main laid, the difference in favor of the long lengths being 2.8 ct. These figures, however, do not take into account the possible extra cost due to cartage, which would probably decrease the difference per foot in favor of the 40-ft. lengths to about 2.3 ct.

The foregoing analyses of cost being all for 8-in. joints, it might be of interest to have, as a guide in order to arrive at the cost of mains of sizes from 1½ in. up, the actual cost of making the joints in the smaller sized pipe.

Table 1 shows these costs arrived at from tests made on joints from 1½ in. to 3 in. The actual time to make 4-in. and 6-in. joints would be about 14 and 20 minutes, respectively; and the cost would be about 55 ct. for the 4-in. and 70 ct. for the 6-in.

These tests show only the cost of labor actually required to make the joint, the costs, including all other necessary labor in connection with the weld, will be governed by the efficiency of the organization.

| Size of pipe Ins. | Time Minutes. | Acetylene Cu.ft. | Oxygen Cu.ft. | Filling Iron oz. | Cost of weld. |
|---|---|---|---|---|---|
| 1½ | 3 | 1.25 | 1.5 | 0.9 | $0.08 |
| 1½ | 2 | 1.0 | 1.0 | 0.8 | .06 |
| 2 | 5 | 2.0 | 2.25 | 1.1 | .13 |
| 2 | 3 | 1.25 | 1.5 | 1.0 | .10 |
| 3 | 7½ | 3.0 | 2.5 | 2.45 | .19 |




## A HANDY CHIP SEPARATOR

The half tone here reproduced from a recent issue of American Machinist shows one of these devices too numerous to mention which are constantly being devised in shops where a supply of compressed air is on tap. It is in use in the factory of the Wheeler-Schebler Carburetor Co., Inc., Indianapolis, and as will be seen is simply an air operated sieve for separating small manufactured articles from the fine chips with which they are mixed. Compressed air at the usual shop pressure passes through pipe A to air cylinder B. This cylinder is 2½ in. in diameter and the piston has 4 in. stroke, the red C connecting it with the sieve, which moving back and forth shakes out the chips into the box below. It will be noticed that the sieve has rollers on the side which enable it to move with very slight friction.

## A BRITISH AUTHORITY ON THE METRIC SYSTEM

The following editorial note from *The Engineer*, London, will be found interesting without a word of remark or explanation from us.

We are invited by the Manchester and District Decimal Association to make a "sympathetic reference" to its work. It is difficult to do so without being misunderstood. The objects of the association are to introduce a new system of decimal coinage, based on the division of the florin into one hundred cents instead of ninety-six farthings, and the "compulsory use, after a suitable transition period, of the metric system of weights and measures in the United Kingdom, and, if possible, throughout the British Empire." Now there is a great deal that may be said in favor of the metric system, and were we invited to undertake the organization and management, under Providence, of a new earth we should probably adopt it in lack of anything better, but the problem is far less simple when the two greatest industrial communities in an existing world have got themselves so wrapped up and bound in by another system that to break away from it would involve enormous difficulties and incalculable expense. Thus far then we sympathize with the Manchester and District Decimal Association, that if things were not as they are we should be hand in hand with it. But things being as they are we cannot support a campaign for the "compulsory use" of the metric system. In accord with all other apostles of the metric system the Association is exercised in its mind about the loss of our foreign trade because we adhere to British measures. Surely all manufacturers who feel that they are losing foreign orders from this cause can do as many have already done, and quote for foreign work in metric figures. There is no need for compulsion, no need to force upon the country something it does not at present want. The law of the land sets up certain legal standards, but it compels their use in the case of a few commodities only. Nearly all manufactured goods may be sold to any standard the maker choose to employ, and if anyone desires to put on the British market machinery made to metric measurements he is at liberty to do so. It is open then to any firm to make according to British measures and sell in foreign parts according to metric, to make in metric measures and sell in Great Britain according to British measures, or finally, to make in metric and sell both at home and abroad in that measure and that measure only. In the course of time, ages perhaps, the matter would settle itself, and the metric system might become really universal, but as long as the two biggest industrial countries feel that its forced introduction would hinder rather than help their general trade then the world is not ripe for its adoption to the exclusion of all others.

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## NOTES

Miners' Circular No. 23, of the Bureau of Mines, says that injuries to the eye should be treated as follows: If the eye is badly hurt, as by a blast, it is best not to try to remove the bits of rock, etc.; quickly cover the injured eye with a bandage compress (not picric-acid gauze) or clean cloth or cotton, and tie loosely. Do not allow the patient to rub the eyes, but lead or carry him to a doctor as soon as possible. If the eye has merely a small piece of rock or other material in it, close both eyes for about half a minute and moisture from the eye may form and wash away the particle. If this remedy fails, close both eyes, pull the upper lid over the lower lid two or three times, close the nostril on the other side of the head with the finger, and blow the nose hard. Bandage the eye and wait for the doctor's aid.

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We obtain from sugar about five times as many calories as from the same market value in beefsteak. We get from sugar three times as many calories at half the price we would pay for eggs, and our purchase of sugar will give us just about three times as much available energy as would the same amount expended for such a nutritious article as cheese.

We would not contend, of course, that sugar alone will provide a satisfactory diet or that it can be made to take the place of any of the other foods mentioned. But the truth remains that penny for penny we get far more actual energy from sugar than from any other commodity of everyday use, and that sugar is, therefore, the cheapest food we buy.

Small balloons carrying automatic registering apparatus and employed in investigating the upper atmosphere at Batavia in the island of Java quite near the Equator have given some interesting results. The mean temperature at sea level is 78.8 F. At a heighth of 2.92 miles the temperature was at the freezing point, 32 F., at 6.2 miles it was—29.2 and at 10.56 miles it was—119 deg. F. In England such extremes are not reached. At 6.2 miles the temperature is—59.8 and at 10.56 miles it is—65.2.

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The *Cairns Post* of Australia relates with a good deal of interest, the excitement and wonder caused in a certain town by the arrival of huge grey objects resembling submarines, which, as everybody knows, go to the basement of the ocean their wonders to perform. However, these objects were not submarines, but next thing to it in this way: They were tanks loaded with molasses and sent to Cairns. The molasses is run into tanks within ships and taken south and is turned into an article used for the manufacture of explosives. Up to now the sugar industry has not been of any military importance save as a means of fortifying against hunger. Sugar has always been first in peace and it seems now it is to be first in war, for war is dependent on explosives first of all.

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A gang of workmen engaged in blasting rock in the Twin Peaks tunnel at San Francisco returned to work after a round of shots had been fired and were caught by a delayed explosion. Twelve charges had been placed, the fuses ignited, and from a place of safety the shots were counted as they exploded. One missed fire, but was lost in the count, it being taken for granted that it had exploded simultaneously with one of the other shots. After the usual wait, the gang returned to work, and just as they reached the spot the delayed explosion occurred, killing the foreman and one laborer, seriously injuring two, and causing lesser injuries to five others.

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High-class marine oil engines at the present time command a price of from $60 to $65 per horsepower. Figured on a pound basis, they sell at about 40 cents a pound net weight.

The following, worth reading, is from a Saturday Evening Post love story: When the discerning historian of 3000 A. D. writes of this century he will give less space to the great European war than to the development of gas motors. Already, incredibly, the motor vehicle has changed the face of the earth. It sends the most stodgy city dweller into places where he can find wisdom and fresh air; it has solved that ancient problem of the dissolution of the farm. It has transformed the ways of pleasure; it has even changed the life-old ways of love-making! Though poets still call our attention to roses, a poetry still more magnificent is being sung about us by popping — or sliding — valves. Something of this romantic miracle was realized in the humdrum offices of the, etc., etc.

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A recent snowslide destroyed the compressor house and warehouse of the North Star Mine near Halley, Idaho, and fifteen men were killed. There was a full 30 inches of snow in three days followed by heavy rain.

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## LATEST U. S. PATENTS.

*Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.*

FEBRUARY 6.

1,214,531. POWER GENERATION. Reginald A. Fessenden, Brookline, Mass.

1. The combination of a combined liquid piston internal combustion engine and air compressor, and a turbine adapted to be driven by the compressed air, the liquid piston of the internal combustion engine and compressor being formed by a single column of liquid.

1,214,542. ROCK-DRILL. Charles H. Haeseler, Philadelphia, Pa.

1,214,603. ROCK-DRILLING APPARATUS. William A. Smith, Denver, Colo.

1,214,604. DRILL-SHARPENING APPARATUS. William A. Smith, Denver, Colo.

1,214,607. ROCK-DRILLING MACHINE. William Charles Stephens, Cornwall, England.

1,214,614-5. FLUID-PRESSURE BRAKE APPARATUS. Walter V. Turner, Edgewood, Pa.

1,214,616. ELECTROPNEUMATIC BRAKE. Walter V. Turner, Edgewood, Pa.

1,214,637. AERATING DEVICE. Oscar Zistel, Sandusky, Ohio.

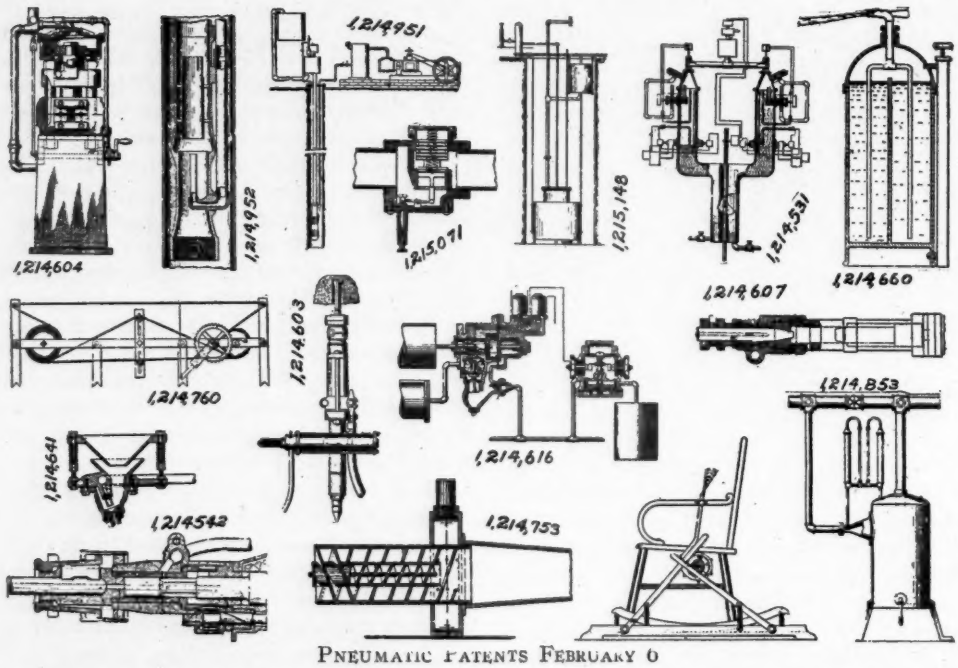
1,214,641. SAND-BLAST APPARATUS. Clarence E. Billings, New Haven, Conn.

1,214,660-61. FOAM-GENERATING APPARATUS. James B. Erwin and Orlando R. Erwin, Milwaukee, Wis.

1,214,665. ROCK-DRILL. Seymour Ferguson, Ocotlan, Mexico.

1,214,727. WELDING-TORCH. Rudolph Vuilleumier, New Rochelle, N. Y.

1,214,753. SYSTEM FOR FEEDING PULVERIZED FUEL. Virginius Z. Caracristi, Albany, N. Y.




PNEUMATIC PATENTS FEBRUARY 6

1,214,760. APPARATUS FOR FILTERING AIR. Sutton Cooper, Evansville, Ind.

1,214,811. PNEUMATIC VEHICLE-WHEEL. Luis Mayolino, Habana, Cuba.

1,214,853. APPARATUS FOR INDICATING THE RATE OF FLOW OF FLUIDS IN PIPES. Charles L. Weil, St. Clair, Mich.

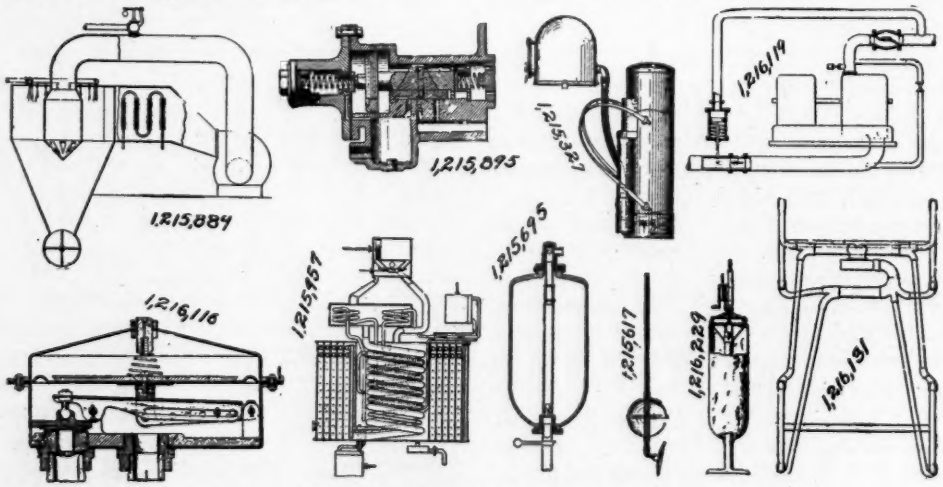
1,214,865. PNEUMATIC ACTION FOR MUSICAL INSTRUMENTS. Morris S. Wright, Worcester, Mass.

1,214,902. AIR AND WATER SEPARATOR. Lincoln S. Deal, Kalamazoo, Mich.

1,214,943. ACCENTING DEVICE FOR MECHANICAL MUSICAL INSTRUMENTS. James O'Connor, New York, N. Y.

1. A pneumatic player for musical instruments including in combination an air pump, an equalizing reservoir communicating therewith, an actuating pneumatic communicating with said air pump and governed thereby, and means actuated by said actuating pneumatic for restraining the operation of said equalizing reservoir.

1,214,951. AIR-LIFT SEPARATOR-PUMP. Oran M. Pruitt, Indianapolis, Ind.

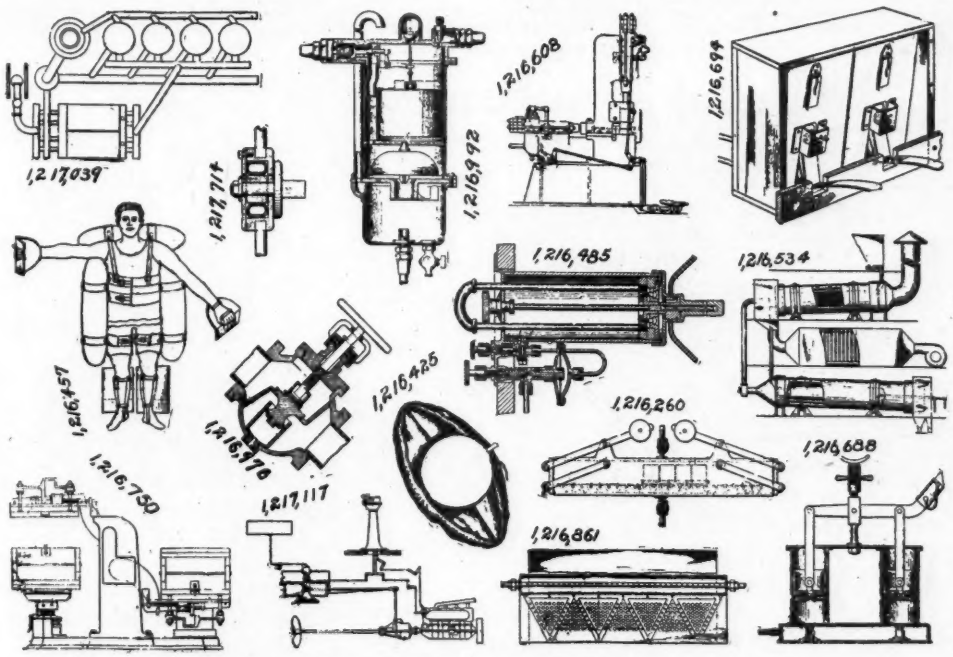



PNEUMATIC PATENTS FEBRUARY 13

1,214,952. AIR-LIFT. Oran M. Pruitt, Indianapolis, Ind.
1,215,071. UNLOADING-VALVE FOR COMPRESSORS. George F. Steedman, St. Louis, Mo.
1,215,103. CHAIR-ACTUATED BLOWER. Michael Blanarik, South Norwalk, Conn.
1,215,148. PUMP. Joseph C. Harbison, Eldorado, Ill.
1,215,192. STEAM-DRIVEN AIR-COMPRESSOR. Dominick A. Reagen, Altoona, Pa.
1,215,221. APPARATUS FOR RAISING WATER. Frederick H. Umholtz, Oklahoma, Okla.

An apparatus of the character described comprising a pair of water containers adapted to be lowered within a water well spaced from its bottom and having valved inlets, a compressed air tank adapted to be located exteriorly of the well, a water discharge pipe common to said containers, a gear casing arranged in said discharge pipe, gear wheels journaled in the casing and meshing with each other, a valve casing connected with the gear casing and having dual communication with the compressed air tank, the said valve casing having a pair of exhaust ports, branch air supply pipes leading from the valve casing to the container, and a valve within the casing having driven connections with one of the gears in the gear casing and adapted to alternately allow admission of air to one receptacle and the exhausting of air from the other receptacle.

1,215,695. FLUSHING APPARATUS WITH AIR-CHAMBER. Frederick Johannes Paff, Utrecht, Netherlands.
1,215,889. PROCESS AND APPARATUS FOR DESICCATING FLUID SUBSTANCES. Richard W. G. Stutzke, Chicago, Ill.
1,215,890. DUST-SEPARATOR. Harry A. Thuneman, St. Louis, Mo.
1,215,895. COMBINED AUTOMATIC AND STRAIGHT-AIR VALVE MECHANISM. John A. Adams, Nogales, Ariz.
1,215,957. APPARATUS FOR LIQUEFYING AND SEPARATING GASES. Rudolf Mewes, Berlin, Germany.
1,216,116. FLUID-PRESSURE GOVERNOR. Harold A. Hayward, New York, N. Y.
1,216,119. ROTARY COMPRESSOR AND THE METHOD OF OPERATING IT. Adolf Hinz, Frankfort-on-the-Main, Germany.




PNEUMATIC PATENTS FEBRUARY 20

FEBRUARY 13.

1,215,327. RESPIRATORY SYSTEM FOR SMOKE-HELMETS. Charles H. Ackerman, Milwaukee, Wis.
1,215,617. BUBBLE-BLOWER. Rafael Diaz Buitrago, New York, N. Y.
1,215,621. PNEUMATIC GOVERNOR. Herbert W. Cheney, Milwaukee, Wis.

1,216,131. MEANS FOR PREVENTING THE RAISING OF DUST BY MOTOR-VEHICLES. Benjamin Jones and Phillip John Rees, Gwaun-Cae-Gurwen, Wales.

1. In means for preventing the raising of dust by the wheels of a motor vehicle, the combination with a vehicle, of pipes having mouth pieces arranged in front and rear of the wheels adjacent the treads thereof and close to the ground, and an air apparatus connected with the said pipes and drawing in the air in front of the wheels and delivering it to the rear of the wheels.

1,216,229. VACUUM-CLEANER. Bertie R. Hall, Outlook, Saskatchewan, Canada.
1,216,254. AIR-SPRING. Lucien R. Gruss, San Francisco, Cal.

FEBRUARY 20.

1,216,260. VACUUM-BOX FOR FRUIT-CANNING. Lewis E. Arnold, Honolulu, Hawaii.
1,216,425. INFLATABLE TOY. Moses H. Eiseman, Chicago, Ill.
1,216,457. SWIMMING DEVICE. Martin Jelalian, Cranston, R. I.

1,216,485. COMPRESSED-GAS CONTROLLING AND IGNITING MECHANISM FOR AUTOMOBILES. Charles J. Pembroke, Rochester, N. Y.

1,216,542. VACUUM-OPERATED BRAKE MECHANISM. Robert F. Berkebile, Kantner, Pa.

1,216,554-5. PROCESS OF GRANULATING AND DRYING SUGAR. Godfrey Engel, Brooklyn, N. Y.

1. The process of drying sugar that consists in disseminating wet sugar in an air passage, disseminating nearly dried sugar in a second air passage and passing air through the second passage and thence through the first passage with the addition of fresh air, whereby the dry sugar dust from the second passage is intercepted by the moist sugar in the first passage.

1,216,608. POWER-HAMMER MECHANISM. Samuel V. Rawlings, Calumet, Mich.

1. In power hammer mechanism, the combination of a hollow frame forming a supply reservoir for motive fluid, a hammer operating motor cylinder mounted on said frame and connected to the supply reservoir therein, and controlling valve mechanism for said motor cylinder.

1,216,664. DRIVING MECHANISM FOR SELF-PROPELED BODIES. Frank W. Dodd, Brooklyn, N. Y.

1. An automobile torpedo and a driving mechanism therefore comprising an engine arranged to be driven by the water in which the torpedo is immersed or on which it floats, and fluid pressure means operated by expansion of gas derived from a source of reservoir kept at continuous pressure for forcing the water through the engine, the water after passing through the engine being exhausted into the surrounding water in a rearward direction.

1,216,677. APPARATUS FOR PURIFYING BLAST-FURNACE GASES. Martin Ernest Feilmann, Donald Bagley, and Arthur Herbert Smith, London, England.

1,216,688. TIRE-INFLATING PUMP. Joseph Heeley, Wigan, England.

1,216,693. BELLOWS FOR PNEUMATIC LEAF-TURNERS. Jarret C. Holcom, Sulphur Springs, Tex.

1,216,714. PNEUMATIC WHEEL. John W. Martin, Pittsburgh, Pa.

1,216,722. APPARATUS FOR IMPREGNATING LIQUIDS WITH GAS. Harrison E. Patten, Silver Spring, Md.

1,216,750. SAND-MOLDING APPARATUS. Henry Tscherning, Freeport, Ill.

1,216,761. WATER-SUBMERGED AIR-CHAMBER FOR WATER-PIPES. Howard H. York, Logansport, Ind.

1,216,841. AIR-BRAKE-OPERATING MECHANISM. William C. Renshaw, Mannington, W. Va.

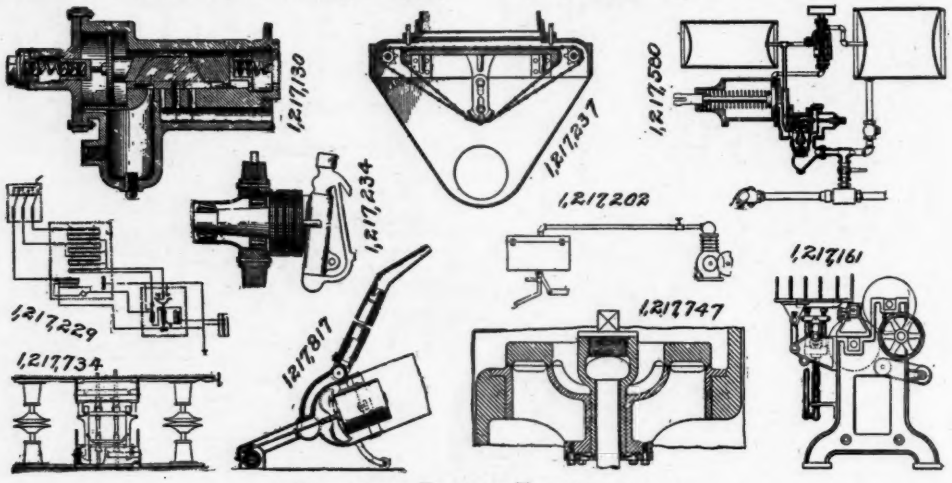
1,216,861. SUCTION-BOX. Napoleon Shorey and Francis P. Flynn, Woodland, Me.

1,216,976. COMBINED STOP-VALUE, AUTOMATIC LIMITED-PRESSURE VALVE, AND FULL-PRESSURE SUPPLY-VALVE. Thomas Burton Ford. Brooklyn, N. Y.

1,216,992. VACUUM-OPERATED LIQUID-FUEL-FEEDING DEVICE. Edgar R. Hawley, Salt Lake City, Utah.

1,217,039. PREHEATING OF AIR FOR HOT-BLAST STOVES OF BLAST-FURNACES. Edward E. Marshall, Philadelphia, Pa.

1,217,117. FLUID-ACTUATED MEANS FOR CONTROLLING AN ENGINE. William H. Curtis, Portland, Ore.




PNEUMATIC PATENTS FEBRUARY 27

FEBRUARY 27.

1,217,130. COMBINED AUTOMATIC AND STRAIGHT AIR VALVE MECHANISM. John A. Adams, Nogales, Ariz.

1,217,161. PNEUMATIC PRESS-FEEDING MEANS. James Duvall, Camas, Wash.

1,217,202. SANDER FOR VEHICLES. Arthus R. Morrissey, Seattle, Wash.

1,217,229. ELECTRIC AIR-HEATING SYSTEM. Elmer J. Smith, Detroit, Mich.

1,217,234. INFLATING SYSTEM. Benjamin O. Stark, Stotesbury, Mo.

1,217,237. PULVERIZED-FUEL FEEDER. Edwin Fergerson Stewart, Woodcliff, N. J.

1,217,580. AIR-BRAKE SYSTEM. Frank H. Dukesmith, Buffalo, N. Y.

1,217,734. AUTOMATIC RAILWAY-CAR AND COMPRESSED-AIR AND STEAM PIPE COUPLING DEVICE. Cesare Feroci, Rome, Italy.

1,217,747. FLUID-PRESSURE VALVE. John Graham and Archibald Graham, Glasgow, Scotland.

1,217,817. VACUUM-CLEANER. Homer L. Peters, Salem, Ohio.

1,217,824. INFLATED APPARATUS FOR PREVENTING DROWNING AND ASSISTING SWIMMING. John James Pritchard, Moseley, Birmingham, England.

1,217,886. PNEUMATIC MASSAGE APPARATUS. Harvey L. Hopkins, Chicago, Ill.